SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXVI JUNE, 1936 WHOLE NO. 314

REACTION TIMER

BY T. J. KUEMMERLEIN

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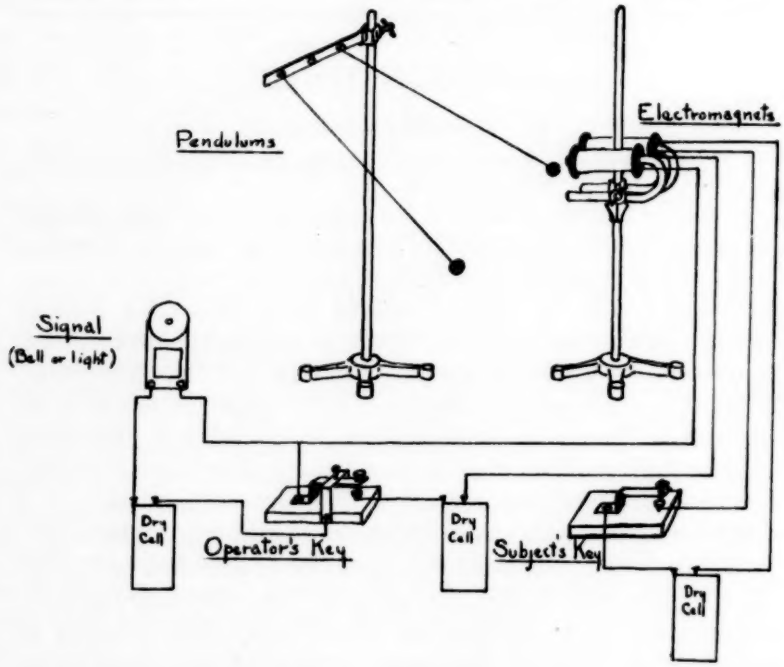
The object of this machine is to measure the length of time elapsing between the reception of a stimulus and the response. This interval is called the reaction time. This is a piece of apparatus that can be set up and used in the physics class, general science class, or as a demonstration at a science club meeting. It involves the use of the simple pendulum and electromagnets. While the explanation of the experiment might be too difficult for some of the ninth grade students to understand, the desire to have their reaction time to certain stimuli measured, makes this an interesting demonstration. The apparatus consists of a stand with a cross-arm from which are suspended two iron balls by fish line cord. The pendulums may be of any desired length. (The lengths used in this particular set-up were sixty-two centimeters and sixty centimeters respectively.) The number of swings or the beat of the longer pendulum was obtained by counting the swings made per minute. The length of time in seconds of each beat of the longer pendulum was found by dividing sixty seconds by the number of swings. The two pendulums were then released simultaneously, and the number of swings that were required by the shorter pendulum to catch up and swing evenly with the longer, was noted. By dividing the time of one swing of the longer pendulum, by the number of swings required for the shorter to catch it, the gain in seconds of the shorter is obtained. The following table might be of assistance in showing the necessary data.

Length of longer pendulum	62	cen.
Length of shorter pendulum	60	cen.
Frequency of longer pendulum	38	per min.
Number of swings required by shorter to catch longer	70.5	swings
Time of one swing of longer $\dfrac{60 \text{ sec.}}{38 \text{ per min.}}$	1.57	sec.
Gain in seconds of each swing of shorter on longer $\dfrac{1.57 \text{ sec.}}{70.5 \text{ swings}}$	.0209	sec.

The rest of the apparatus consists of two electromagnetic releases for the pendulums, controlled by two keys. The operator's



key is of the double contact type which will release the pendulum and ring a bell or light a lamp at the same time. The subject simply holds down his key until the bell rings or the light flashes. By removing his finger, the subject thus releases the shorter pendulum.

In getting a person's reaction time the number of swings the shorter pendulum makes in catching up to the longer must be counted. This number is then multiplied by the gain in seconds of the shorter one on the longer which then gives you the reaction time. For example, if it takes ten swings for the shorter

to catch up with the longer, then ten times .0209 seconds gives .209 seconds, the reaction time to that particular stimulus.

Many adaptations of this device can be made by changing the stimulus or changing the type of release key. It might be adapted to show how long it would take a person to react to a signal to apply the brakes on an automobile. It is possible to develop a safety lesson around this. How quickly an athlete responds to certain signals can easily be measured. As this device has been used in many of my general science classes, I can say that it arouses a great deal of interest.

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SMOKING DULLS TASTE FOR SALT AND SWEETS

Smoking tobacco dulls the acuteness of taste for both sugar and salt, it has been found in experiments conducted at Catholic University of America, by Dr. John E. Rauth and James J. Sinnott. But the effect is not permanent; when the smoking is stopped, the ability to taste returns to normal.

Six habitual smokers who planned to give up smoking for a period volunteered as subjects in the experiment. Tests were used to determine the weakest solution of sugar and of salt that could be tasted by each one. Then they stopped smoking. Their taste became more acute, so that they could taste solutions of sugar only about half as strong as their former limit. Salt could be tasted in solutions about two thirds as strong as for formerly.

The test is keen. Two of the individuals sneaked in a couple of smokes during the non-smoking period. Their taste for sugar betrayed them.

Non-smokers tested as a check on the experiment were very much like the smokers during their non-smoking period.

A PROJECT IN NAVIGATION

By Edna Carlson*
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Significant Idea—The relative motion of the earth, sun, moon and stars determine the conditions which exist on the earth.

Specific Objective—To show how navigators determine their location by observation of the sun and stars.

Essential Question—How is the sextant used to determine latitude at sea?

If we know the angle that the pole star or the sun makes to the horizon, we can tell on what parallel of latitude our ship is located. This angle may be measured with a sextant. (The meridian or longitude is determined by means of the chronometer.) The observer's line of sight to the pole star makes a right angle with his line of sight to the celestial equator, which is a projection of the earth's equator on the sky. His line of

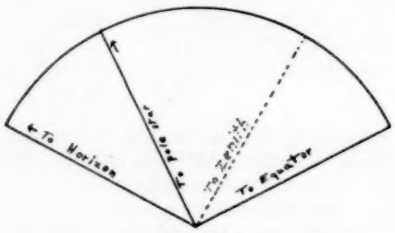

Fig. 1

sight to the horizon also makes a right angle to the zenith, the point directly overhead. As one of these angles increases or decreases, the other increases or decreases with it. This may be made clear as follows. Cut two quarter-segments of a circle. Mark one radius (the cut edge) of one "to horizon" and the other radius of this quadrant "to zenith." Similarly mark the edges of the other quadrant "to pole star" and "to equator." Fasten these two quadrants together with a split paper fastener. (See Fig. 1.) It will be helpful if the top quadrant is made of transparent material so that the lettering on the bottom one may show through. With this simple device it will easily be seen that as the angle between the horizon and pole star increases or decreases, the angle between the zenith and equator changes by a like amount. Therefore if one measures the angle

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from the pole star to the horizon, one has automatically measured the distance of his zenith from the point where the plane of the earth's equator cuts the sky. Therefore, he has measured his latitude, for latitude is the distance north or south of the equator. Let us say the same thing in another way. If the north pole were extended far off into space it would almost go through the north star. If you stood at the north pole the north star would be right overhead. Also, if you were at the equator the north star would appear in the north, very low on the horizon. If you were below the equator you wouldn't see it at all. If you were half way between the equator and the north pole it would appear at a forty-five degree angle. It appears about that to us (New Britain, Conn.) because we are near the forty-first parallel of latitude. So the observer's latitude determines the angle

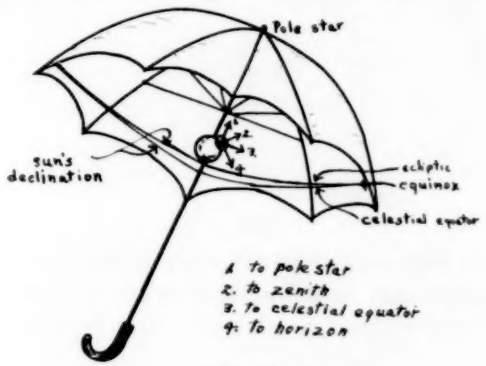

FIG. 2

which the north star makes to the horizon. Because the earth is as a mere grain of sand in the universe, it is easy to understand that any line parallel to the earth's axis will appear to point just as close to the pole star as the line of the axis does. Thus the line of sight of an observer of the north star located any where on the earth will be parallel to that of any other observer.

When observing the sun the problem is a little different because the sun does not cross the sky every day in the plane of the earth's equator. If it did, one would have only to measure the height of the noon sun above the horizon and subtract it from ninety degrees to find his latitude. The sun is only in this position, however, at the spring and fall equinoxes. During the rest of the year the observation must be corrected by the distance that the sun is north or south of the equatorial plane on that

day. This declination is given for each day of the year in the Nautical Almanac. In the summer, when the sun's declination is north of the equator the correction must be added to the distance between the sun's position and the zenith. In the winter it is subtracted.

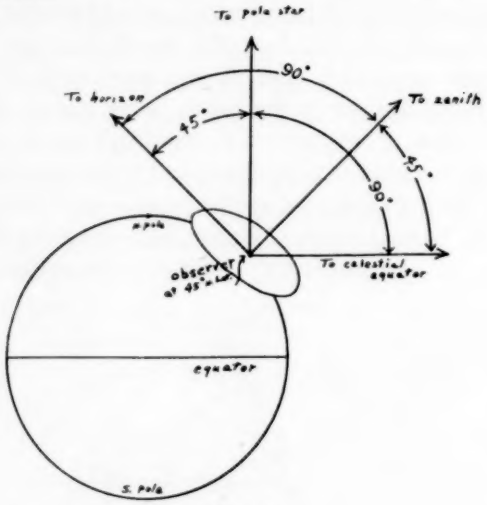

FIG. 3

A device to help make clear the relationship of the sun to the celestial equator may be made from an old umbrella. The celestial equator and ecliptic (sun's path) are chalked on the inside

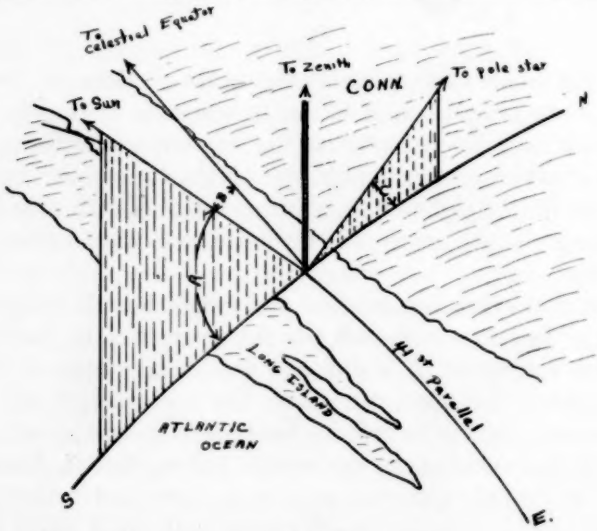

FIG. 4

of the umbrella. The positions of the main constellations may also be marked on the inside of the umbrella fabric (Fig. 2). A tennis ball is attached to the umbrella rod to represent the earth. A disc of cardboard pinned to the ball represents the horizon of the observer. This may be placed at different latitudes to illustrate the effect of latitude on appearance of the sky.

The culminating activity in connection with this project is the construction of a sextant and the taking of observations with it. Diagrams make clear its construction. Detailed directions are given in the *Popular Science Monthly* for September 1933, p. 34. To operate the sextant look through the telescope at the horizon through the clear part of the horizon glass and

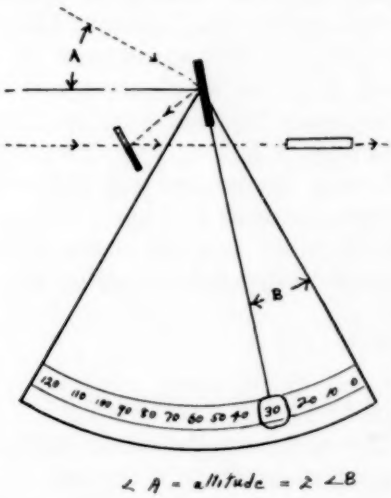

FIG. 5

move the radius arm until you can see the sun or pole star in the silvered half of the horizon mirror, the rays of which have been reflected to it by the index mirror. Read the angle to which the arrow points on the scale. The scale is made to read the elevation above the horizon (altitude) directly, although the actual angle of the radius arm is one-half that of the altitude. If the sun is being "shot" the correction for its declination must be made. Following is the actual data from an observation made with the instrument illustrated in Fig. 5.

OBSERVATIONS OF THE SUN WITH SEXTANT

Date: Nov. 9, 1935

Altitude as determined by sextant: 32°
Declination as determined from tables for Nov. 9, 1935—17° South
90° − (Altitude + declination South) = latitude: 90 − (32 + 17) = 41°
Actual latitude of New Britain: 41° 40′ North

Of course it is difficult to make accurate observations of this type on land due to the unevenness of the horizon unless one can go to a fairly high elevation.

Illustrative Materials Required

1. A movable diagram which shows the relationship between Horizon-pole star and Zenith-Equator. (Fig. 1)
2. An umbrella which has been made to show: the earth with its equator and its poles, an observer and his horizon and zenith, the location of the pole star, the sky's equator and the path of the sun. (Fig. 2)
3. A diagram showing the relationship of the umbrella model to the angles being measured. (Fig. 3)
4. A diagram showing just how the angles would be measured on the 41st parallel when sighting either the sun or the pole star. (Fig. 4)
5. A model sextant. (Fig. 5)

Related Problems Studied in the Grades

1. Positions of stars and constellations at different times during the year. Use the umbrella as a sky map. Grades 5 to 9.
2. An understanding of latitude, longitude, parallels, meridians. Grades 4 to 6.
3. A study of how ships find their way. Grade 6 and above.
4. A study of the seasons as influenced by the sun's path. Use umbrella to make clear relationships of ecliptic and celestial equator, equinoxes and solstices. Grades 5 to 9.
5. Angular measurement and the simple geometry involved in the action of the sextant.

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THE INTRODUCTION TO PLANE GEOMETRY

By M. Richard Dickter

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Plane geometry is a difficult subject to most students, partly because of lack of interest on their part and partly because it takes a long time for the meaning of and necessity for a proof to dawn upon their minds. The difficulty is aggravated by the large amount of ground that must be covered the first term in the usual course. The situation results in haste at the start and, as a consequence, the student is presented with formal demonstration before he is ready for it. He rapidly sinks in the flood of proofs and fails. Even many of those who pass never fully appreciate the concept of demonstration, which should be the main outcome of the course. "Make haste slowly" in the beginning is good policy in plane geometry. An interest-stimulating approach and a gradual introduction to formal demonstration will pay good dividends in the end.

Demonstrative geometry may be introduced in several ways: (1) by plunging into demonstration at once; (2) by a study of definitions; (3) by means of problems; (4) by means of the constructions. Each of these methods will be considered in turn.

Formal demonstration, immediately following the mere memorization of a page of axioms and postulates, was the traditional method of beginning the course. The futility of such a start, except, possibly, for superior, mature and interested students, is obvious. Its consequences have already been pointed out and no more need be said here on that score.

Approaching geometry through a study of definitions is one certain way of ruining whatever interest the student may have in the subject to begin with. Moreover, the method lacks effectiveness because the definitions mean nothing to the child at this time. The point to keep in mind is that a definition should be learned at the time when it is needed for application.

A third method of introducing geometry is by means of practical problems. At the beginning of the term the teacher may introduce, or, by judicious guidance, lead the pupils to formulate, a practical geometric problem in the solution of which numerous theorems, constructions and definitions are encountered and these are learned when needed. The advantages of this

method of approach are: (1) the child learns to make numerous constructions; (2) concepts and definitions are learned when the need for them arises; (3) the child sees some purpose in what he is learning, although this feature depends to a great extent upon the reality for him of the problem selected for solution; (4) the child is brought to appreciate the practical value of mathematics—here, again, the extent to which this outcome is realized will depend upon the nature of the problem selected for solution, for, while the problem may be practical enough, yet the pupil may be too young, his knowledge of the world too limited, to realize this; (5) the child sees the necessity for a proof because his statements have been challenged. On the other hand, the method has several serious disadvantages: (1) it is difficult to find problems that will fulfil all the necessary requirements, that will include the proper sequence of theorems, constructions and definitions, that will not be too complicated, that will appear real to the pupil, and that will be practical and yet within the ken of the pupil's experience; (2) there is the danger of insufficient drill-work—the teacher may not spend enough time on a given part of the material to fix it in the pupil's mind; (3) there is also the large danger that the teacher will leave in a disorganized form the geometry that has been taught; (4) the teacher may start with a practical problem too complicated, involving too many theorems, and become lost in the maze that follows.

The approach of geometry through constructions has a great deal in favor of it: (1) the method is simple and clear, easy to carry out; (2) concepts and definitions are learned at the proper time; (3) the constructions are effectively learned; (4) the child learns to use drawing instruments; (5) this type of approach has a tremendous appeal for children. Two objections to this approach have been made. They are: (1) some children may not ordinarily see any purpose in what they are doing—this objection is not common only to this method or subject and may be overcome to some extent here, as elsewhere, by an appeal to the practical through simple practical illustrations and problems that abound in a number of the more modern textbooks; (2) geometry so taught may become mechanical—this danger may be true where the laboratory method of teaching geometry is used throughout the entire course; but not here, where only the constructions that must be taught anyway are presented at the beginning. Moreover, too much time, to the exclusion of

other features of the work, need not be spent on them at this stage.

Of the four methods of approach mentioned, the first two, the approach through immediate demonstration and the approach through definitions, need not be considered. The choice, then, must lie between the approach through problems and the approach through constructions. A consideration of the pros and cons of these two methods appears to favor the approach through constructions, at least for the beginning teacher. There are too many serious dangers for both teacher and pupils involved in the approach through problems. It can be used successfully only by a highly skilled and experienced teacher.

The writer has worked out a series of lesson plans comprising an introduction to demonstrative geometry through the first four theorems, and embodying a number of the newer ideas in teaching geometry. The approach is by means of the constructions and the pupil is gradually accustomed to the meaning and use of demonstration. The writer has used the plan successfully in the classroom and he presents it here briefly in the hope that it may be of service to others, particularly to teachers who may be teaching plane geometry for the first time. Before doing so, it would be desirable to summarize the essential features of this plan:

1. The total time consumed for the introduction is four weeks, not too long, so as to necessitate undue haste at the end of the term, and yet sufficiently long gradually to accustom the pupil to demonstration. By the time the four weeks are over the pupil has already covered the first four theorems of Book I and has had plentiful opportunity to practice their application.

2. An attempt is made in the very beginning to present attractively a colorful and practical appeal to the pupil.

3. Only the most essential axioms, postulates and definitions are presented and these are considered at the points where needed.

4. The arbitrary nature of the axioms and postulates, the fact that they are merely useful, and not the only assumptions, is emphasized.

5. The pupil is led to formulate for himself the axioms, postulates and some of the theorems by means of illustrations and experimentation.

6. The axioms and postulates are applied in simple exercises before even the first theorem is considered.

7. Time is allowed to impress the concepts of superposition and congruence upon the pupil.

8. The pupils are drilled on the terms "included angle" and "included side," so confusing to them and yet so often neglected.

9. The pupils are given practice in the very beginning on selecting the hypothesis and the conclusion from statements and on drawing and lettering figures for theorems. Too much time cannot be spent on these points at the start; in fact, they should never be neglected throughout the entire course.

10. Each of the first four theorems is applied before the next one is considered.

11. The method of corresponding parts to prove two lines or two angles equal is introduced immediately after the first theorem and applied.

12. The pupils are led to formulate for themselves the first two theorems formally proved and then to prove them as originals by means of analysis.

13. The pupils are presented with a suitable form to be used in proving theorems and given directions to help them study geometry.

14. It is suggested that the pupils be asked to check their constructions, and some of the theorems, with ruler and protractor. This practice should gradually be eliminated. It is valuable in the beginning only because it makes the work more real, more concrete, to them. The attitude of the pupils on this score may be summed up by the remark of one of them after he had checked his construction: "Gosh, it's really so! It works!" As the pupils come to accept without doubts the truth of what they are proving, checking need no longer be used.

15. The s.a.s. and a.s.a. congruence theorems are demonstrated experimentally. The superposition proofs may be discussed informally at this point, if so desired, and the pupils held responsible for them later in the course. Experience has shown that the superposition proofs are quite meaningless to the pupils at this early stage of the work and merely lead to memorization and early discouragement.

The plan itself now follows. Each numbered item represents the approximate ground to be covered in one lesson.

1. If possible, show the class a series of linoleum and tile designs that can be drawn with straightedge and compass. The writer has a large collection of such designs, exquisitely colored, and he has found their use stimulating and effective. These

designs can very easily be obtained from the appropriate concerns. Several enlarged designs of the same type, made by the teacher and displayed in the room, can be used instead. Explain to the class that all constructions in plane geometry are made with straightedge and compass only, and why. Permit the pupils to make one or more designs of their own, using only straightedge and compass.

2. Constructions: to construct an angle equal to a given angle, to bisect an angle, to construct the perpendicular bisector of a line. Verify the constructions with ruler and protractor.

3. Constructions: to construct a perpendicular to a line at a point on the line and to construct a perpendicular to a line from a given outside point. Verify the constructions. Review the previous constructions by means of suitable exercises.

4. Constructions: to construct a triangle when the three sides are given, to construct a triangle when two sides and the included angle are given, to construct a triangle when two angles and the included side are given. Review the previous constructions by means of suitable exercises.

5. Construction of right triangles. Review the previous constructions by means of suitable exercises. At this time assign to each pupil as a project the making of a linoleum, rug, tile or mosaic design, using only straightedge and compass and the constructions he has learned thus far. The design is to be colored and handed in within one week.

6. Discuss the axioms and postulates, just those necessary at the very beginning to start the work. Let pupils formulate them from numerical and geometric illustrations. Explain the necessity for the axioms and postulates and their arbitrary nature. It is interesting at this point to tell the class the story of Euclid's postulate of parallels and non-Euclidean geometry.

7. Let the pupils formulate the following assumptions from illustrations and experimental demonstrations: two straight lines can intersect in only one point, a line can be bisected by only one point, an angle can be bisected by only one line, all straight angles are equal, all right angles are equal, only one perpendicular can be drawn to a line at a point in the line only one line can be drawn parallel to a given line through a point outside the given line. Where possible, prove the assumptions informally with the aid of the class by means of the axioms and postulates. In this way the pupils will see how the axioms and postulates are applied and gradually become accustomed to a proof.

8. Continue with the following assumptions in the same way as in Lesson 7: complements of equal angles or of the same angle are equal, supplements of equal angles or of the same angle are equal, the sum of all the angles about a point on one side of a straight line through the point is a straight angle, the sum of all the angles about a point is equal to four right angles, the vertical angles formed when two straight lines intersect are equal, the sum of any two sides of a triangle is greater than the third side.

9. Simple objective exercises applying the axioms, postulates and assumptions. Matching exercises, with a series of exercises in one column and reasons consisting of the axioms, postulates and assumptions in the other column, are interesting and effective.

10. Meaning of congruence and superposition. Exercises in selecting congruent pairs of figures and exercises in describing the motion by which one of a congruent pair of figures can be made to coincide with the other.

11. Theorem: if two sides and the included angle of a triangle are equal respectively to two sides and the included angle of another triangle, the two triangles are congruent. Let the pupils formulate this theorem by experimenting with triangles cut out from paper, after the question has been raised as to whether it is necessary to know that all the six parts of one triangle are equal to the corresponding six parts of another triangle in order to establish the congruency of the triangles. Drill on the meaning of the term "included angle." If desired, the formal superposition proof for the theorem may be developed with the aid of the class and the pupils held responsible for it later in the course. Introduce the terms "theorem," "hypothesis," "conclusion." Drill on selecting the hypothesis and conclusion in statements.

12. Simple exercises applying the s.a.s. theorem. Continue the drill in selecting the hypothesis and conclusion from statements.

13. Further exercises applying the s.a.s. theorem. Drill pupils on drawing figures for geometric statements and lettering these figures, then changing the hypothesis and conclusion to "given" and "to prove," respectively.

14. Introduce the term "corresponding parts of congruent triangles." Drill on selecting corresponding parts. By means of a demonstration show how the method of corresponding parts

can be used to prove two lines or two angles equal. Easy exercises in proving two lines or two angles equal by means of corresponding parts of congruent triangles.

15. Theorem: if two angles and the included side of one triangle are equal respectively to two angles and the included side of another triangle, the two triangles are congruent. Let the pupils formulate this theorem after experimenting with triangles cut out from paper. Drill on the meaning of the term "included side." If desired, the formal superposition proof for the theorem may be developed with the aid of the class and the pupils held responsible for it later in the course. Easy exercises applying the a.s.a. theorem.

16. Additional exercises applying the a.s.a. theorem. Also, some exercises applying the s.a.s. theorem.

17. Theorem: in any isosceles triangle the angles opposite the equal sides are equal. Let the pupils formulate the theorem after measuring the angles opposite the equal sides in an isosceles triangle. Develop the formal proof for the theorem analytically as an original with the aid of the class. Bring out the reasons why a geometric proof is better than an experimental verification. Show the class the form to be used in writing out a geometric proof. At this stage it is well to give the pupils specific directions on how to study geometry.

18. Exercises applying the isosceles triangle theorem and making use of the first two congruence theorems.

19. Theorem: if the three sides of one triangle are equal respectively to the three sides of another triangle, the two triangles are congruent. Develop the proof for the theorem analytically as an original with the aid of the class. Exercises applying the s.s.s. theorem.

20. Exercises applying the first four theorems.

VITAMIN C HELPS TB PATIENTS BUT IS NO CURE

Doses of anti-scurvy vitamin C given in pure form, or of orange juice in which the vitamin occurs naturally, improved the condition of tuberculous patients, Drs. Molly Radford, Eugene de Savitsch and Henry C. Sweany of Chicago reported at the New Orleans meeting of the National Tuberculosis Association.

The vitamin is in no sense a cure for the disease, the Chicago physicians stated. They used it in addition to the routine rest regimen their patients were receiving in a sanatorium. The reported improvement of the patients as compared with controls who received no extra vitamin C was indicated by laboratory tests, particularly of the blood.

A PHYSICS DISPLAY CASE

By J. W. Moelk

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The physics teacher in the high school is constantly on the alert for interesting and worth-while projects to engage the ambitious and capable student. There are, of course, the usual book reports, talks, and "extra-credit" papers, but the class in physics always contains a number of students who love to tinker and who are usually skillful at making models, toys, and assembling the school apparatus for new and unusual experiments. A physics display case affords a wonderful opportunity for project work for this type of student. It also gives recognition and school-wide publicity for meritorious work as well as some fine advertising for the physics department. Interesting displays of apparatus illustrating physical principles attract the attention of a large number of students who otherwise might not have the opportunity to study physical phenomena.

The building of the case itself can become a good project. The one in use at the present time is about three and one-half feet high, three feet wide, and fifteen inches deep. The front of the case consists of a hinged door, equipped with a window of double strength glass, and a cabinet lock. The inside of the case is equipped with two plate glass shelves and adjustable shelf supports. A false bottom extends about six inches above the bottom of the case and contains two double receptacles of the ordinary wall outlet type and a toggle switch. The space under this false bottom contains the necessary wiring to connect one receptacle with the toggle switch. The current from the other receptacle can be controlled by a push button located on the front of the case, just below the door. The electrical system of the case is connected so that 110 volts A. C. can be used. Inside the case at the top two properly shaded lights are installed which furnish plenty of illumination. Lights and display apparatus can be made to function continuously, or can be controlled by the observer using the outside switch.

One of the simplest yet most interesting exhibits is a display of the Crooke's Radiometer. A heating coil is placed about two feet from the radiometer and is connected electrically so that it can be controlled by the outside switch. A short, concise explanation is written on a card by the student in charge of the exhibit and is signed by him.

Another simple exhibit is the electric whirl. The rotating part is made very light and the whole is energized by the high voltage terminal of an old "Model T" spark coil. This in turn is energized by a toy transformer which can be controlled by the outside switch. The transformer and spark coil are concealed, while the connecting wire is so thin as to be almost invisible. The card carrying the usual explanation contains only the question, "How does this work?". This evokes a great deal of curiosity and the explanation is printed in the school newspaper the following week.

Some of the other displays possible are:

1. Student-made steam engines, motors, electroscopes, hygrometers, etc.
2. Exhibit of various radio tubes.
3. Geissler tube display.
4. Working demonstration of a bi-metallic thermostat.
5. Maps of magnetic fields made with iron filings on wax paper.
6. Model aeroplane exhibit. A student displayed six built-to-scale models of various types of World War fighting planes, showing two each week. This exhibit received much favorable comment in a special article in the school newspaper.
7. Cathode tube demonstration. Energy is supplied by a Ford spark coil, controlled by the outside switch. The tube is placed against the window, and the cathode beam can be controlled by a bar magnet which is chained to the bottom of the case for the use of the observer.

The most elaborate display so far is an exhibit showing how the star Arcturus was used to light up the Century of Progress Exposition. Fig. 1 shows how, with the aid of the photoelectric cell, D, this exhibit is set up. A one hundred watt light, B, is placed near the top and at one side of the case. A black paper tube, A, with vanes cut in the top and a one-inch hole cut in the wall is placed over the bulb. Convection currents from the light cause the shield to rotate about twelve times per minute so that a beam of light travels down the cardboard tube, C, periodically. This tube represents the observatory telescope, and at the bottom end the photoelectric cell is placed. The cell is connected electrically to the relay system which operates a 110-volt light placed inside the modernistic model building which was fashioned by one of the students. Each piece of the exhibit is labeled clearly. Thus the light from the home-made

Arcturus courses down the barrel of the telescope approximately every five seconds and energizes the photoelectric cell. Each time this happens the World's Fair building lights up faithfully.

The demonstration apparatus designed to show the operation of the automobile engine furnishes another interesting display. The flywheel of the apparatus is grooved to take a belt and is

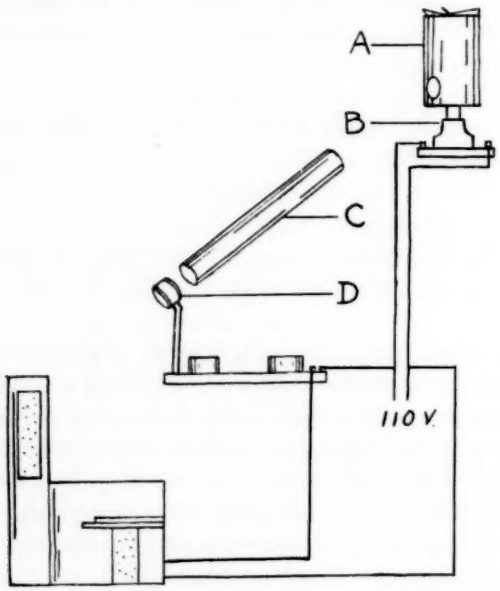

FIG. 1.

then operated by means of an electric motor attached to a speed reducer. The machine is timed so as to make the four strokes in about eight seconds. Parts such as valves, piston, connecting rod, cams, and spark plug are labeled.

These suggested displays by no means complete the list of possibilities. While regular physics demonstration pieces have been largely used, there is a great opportunity for the use of home-made apparatus fashioned by the students.

WORDS WHICH TRIP US

Not all the words which trip us up in pronunciation are long and formidable-looking. The following list is fairly innocent in appearance, but we believe that the average person, running through it, would have to turn to his dictionary, at least once, for first-aid: *finance, azure, condolence, indisputable, status, gibberish, conversant, grimace, pianist, scenario.*

BIOGRAPHICAL CONTENT OF HIGH SCHOOL CHEMISTRY TEXTBOOKS*

By Sister M. Agnese, N. D.
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Introduction: The value of the biographical content of the chemistry text for the pupil of science gave rise to the subject matter of this study. As biography may form a considerable part of the textbook, the résumé of data herein assembled and interpreted may offer suggestions to those interested in textbook content. The problem, therefore, is a critical analysis of the biographical material as it has been incorporated in the high school chemistry textbooks of the past century. In other words, are the biographies of the chemists of sufficient value to constitute a permanent source of interest for the pupil, and therefore should they be included in the chemistry course?

Procedure and Findings: The sources of the material herein contained were two: (1) the replies to a questionnaire and (2) the biographical content of forty-eight high school chemistry textbooks, with dates of publication ranging from 1834 to 1931.

The questionnaire was devised and sent to three groups of educators: authors of chemistry textbooks, educational experts (instructors in the physical sciences at teacher-training schools), and classroom teachers of chemistry.

THE QUESTIONNAIRE

1. Do you think that the high school chemistry textbooks now in use contain a sufficient quantity of biographical material?
2. If you think that there is an insufficient quantity of such material, what ought to be the nature of the type of material included?
   a) Should it be purely statistical in nature, (birth, death, nationality)?
   b) Or give the outstanding contributions of the chemist to science?
   c) Or the important items of the life history of the scientist?
3. Do you think that the inclusion of the material you have suggested above, would contribute materially in arousing a permanent interest in the science of chemistry?
4. In the event that you do not think the inclusion of biographical material necessary, will you kindly state your reason or reasons for your opinions?

A seventy-one per cent return was realized which gives ade-

* This article is based on certain major parts of an unpublished dissertation presented to the Board of Graduate Studies of Notre Dame University, Notre Dame, Indiana, July 1935, in partial fulfilment of the requirements for the degree of Master of Arts, under the direction of the late Rev. John Cavanaugh, C.S.C., D.D., LL.D., and of Professors Leo F. Kuntz and H. B. Froning, to whom grateful acknowledgment is hereby made.

quately the opinions of those whose interest was aroused. Table I gives a résumé of the replies to the first point of the questionnaire.

TABLE I
PER CENT OF REPLIES TO POINT ONE OF THE QUESTIONNARIE: "DO YOU THINK THAT THE HIGH SCHOOL CHEMISTRY TEXTBOOKS, NOW IN USE CONTAIN SUFFICIENT QUANTITY OF BIOGRAPHICAL MATERIAL?"

	No	Yes
Number Replying	280	120
Authors of Textbooks	15%	8%
Educational Experts	15%	0%
Teachers of H.S. Chemistry	39%	23%

Of the two hundred and eighty educators who expressed themselves negatively, fifteen per cent were authors. The query may be raised by the reader, "Why did not they as authors embody suitable biographical material in their texts?" It is possible that this question had not occurred to them while their books were in the process of formation. One author candidly stated that the biographical content of his text was strictly limited by publishers and was not satisfactory to him. A similar number of educational experts, that is, those engaged in teacher-training courses for science teachers, shows that fifteen per cent of those replying negatively, stated that the biographical content of chemistry textbooks is insufficient. To quote one reply: "They do not (contain sufficient biographical material). Some have none, which is inexcusable. Others are inadequate." This reply came from a nationally known educational expert whose work in teacher-training circles is outstanding. The remainder of replies in the negative comes from teachers actively engaged in teaching high school chemistry. A percentage of thirty-nine represents the negative replies of this group. A few of the representative replies may be quoted here: "It seems to me that some of the textbooks are rather weak in biographical material, especially with respect to the chemists of the last fifty or sixty years." Another wrote of the biographical material: "Not of the type of material I prefer."

The one hundred and twenty replying affirmatively make up 31% of those who replied to the questionnaire. Of this group, 8% represents the authors. "The present books are already large and inclusion of such material would make them un-

wieldy," is a characteristic reply from this group. It is to be noted in the Table that not a single educational expert replied that there was sufficient biographical material. Of the 31% replying affirmatively, 23% is represented by teachers of high school chemistry. It is to be noted that those who did reply in the affirmative did so with limitations, as is evidenced by the following quotations: "In some cases additional biographical material might be advantageous"; "Yes, unless there is added some biographical sketches of younger or living chemists and physicists"; "Yes, in the book, but it should be supplemented by informal incidental remarks to add interest and incentive."

Summarizing the replies as shown in Table I, the majority of educators to whom the questionnaire was addressed are not satisfied with the biographical material included in the chemistry textbooks now in use; the minority express themselves satisfied, but however, with limitations.

The reasons for the opinions expressed were asked in items two, three, and four of the questionnaire. One teacher asks that specific data be given regarding the nationality of the chemist, in order to show "the internationality of science." Another, a professor nationally known in teacher-training circles, asks for human interest features and lists "Father's occupation, name of wife, age of marriage, number of children, what THEY did, etc.," as his idea of biographical data. Another asks for the "Time of discovery, invention, etc., and just how the scientist's contributions changed contemporary thought." One teacher states that he never fails to tell his students "about Boyle's difficulties in experimenting or the poorly equipped laboratory in which Morley's work was accomplished—I make the hero of the text human." One author of a text states that biographical data "will show a basis for permanent concepts now used." Another asks that it should show "the incentive that impelled the worker." To quote yet another—"it (that is, items of life history) makes for character and added personality."

This same group, a few of whose opinions have been cited, stated that they supplement their teaching of formal chemistry with biographical material, the inclusion of which they are convinced arouses permanent interest in the science. Their many years as successful teachers would seem to justify their method. One of this group remarked that he uses some four hundred and eighty lantern slides of the leading scientists, in his efforts to arouse permanent interest in chemists. Another says that it

causes his pupils "to remember the men" when he "talks about the man." One author claims that biography is the basis for the scientific method and "by repeating some of the simpler historical methods we may assume a capacity for mastery, while such an assumption is not well founded otherwise."

The views of the 31% who replied affirmatively to Item 1 of the questionnaire constitute another distinct school of thought. This group is made up of high school teachers in the field of chemistry who are satisfied with the biographical data as found. Some of them prefer to consider biography as supplementary reading, referring students to a History of Chemistry, such as Meyer, Moore, Harrow and others. Several are of the opinion that biography is history, and hence, exclude it from chemistry, on the basis that chemistry should be a study of the elements and their compounds, regardless of the men whose efforts have made these studies possible. One teacher thinks that biography makes chemistry less clear and simple for the student. Another teacher says that he does "not find students interested in biography as a rule." One says that due to biography, the text he uses is too large and that it distracts from the development of the subject—hence "would hardly add interest, as it would be something more to be studied." One teacher asserts that his pupils do not read the biographical data at all. Another says that the "limits of the high school chemistry course will not give sufficient knowledge of the value of contributions by various chemists to justify an attempt at appreciation." To quote one more, "Biographical material is not chemistry."

In summarizing the facts shown by the questionnaire, it is evident that the majority is of the opinion that the inclusion of suitable biography would arouse permanent interest in the science of chemistry, by giving the youthful minds a knowledge of the lives and work of these men and women resulting in an enrichment of the subject and further serve as an encouragement consequent upon the acquaintance with the great minds of the past.

An analysis of the biographical content which formed a part of the textbooks used during the past century up to and including those now in use in the high school classroom was next made. A survey of the textbooks being used by those who responded to the questionnaire, indicated a variety of titles. Four of the textbooks are used by 80% of those who replied to the questionnaire—and the four texts are extensively used at the

present time throughout the United States. All of the texts used by those whose opinions were considered have been reviewed by the writer and are discussed in the following paragraphs.

Forty-eight representative texts that were used during the last century were critically studied. Because of outstanding

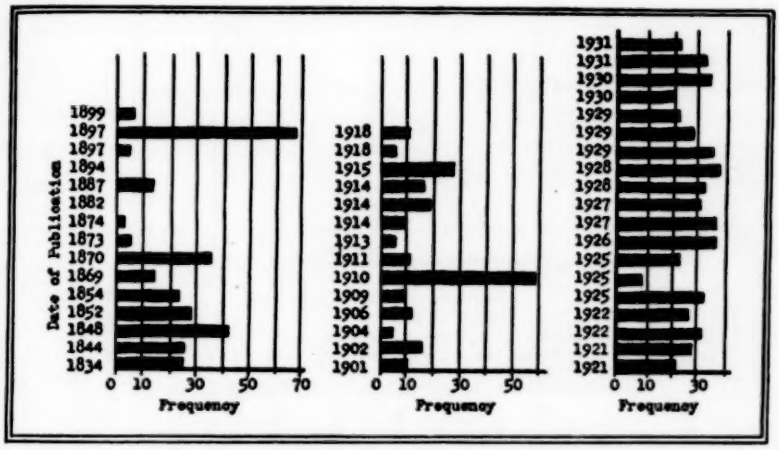

FIG. 1. Distribution of Biographical Data of Forty-eight Chemistry Textbooks During Three Periods of Years, 1834–1899, 1900–1919, 1920–1931.

characteristics, the books were divided into three groups, namely, from 1834 to 1899, from 1900 to 1919, and from 1920 to the present. It is to be noted (Fig. 1) that the larger number of bars representing Periods One and Two, range between zero and thirty; whereas, for the Third Period, they range between thirty and forty. There is a marked tendency toward an increase

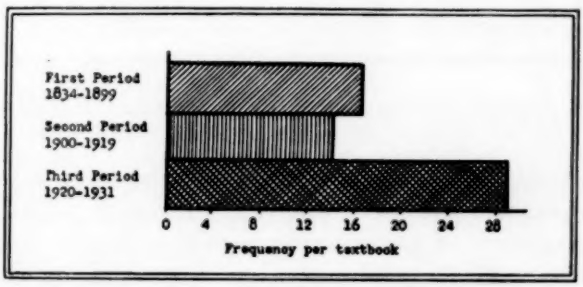

FIG. 2. The Average Biographical Content of Chemistry Textbooks During Three Periods of Years, 1834–1899, 1900–1919, 1920–1931.

in biographical data during the Third Period. This was also evident when the Average Biographical Content per Textbook (Fig. 2) was analyzed. Another phase of biography, Portrait Frequency (Figs. 3 and 4) revealed that there has been a rapid increase in the number of portraits which have been incorpo-

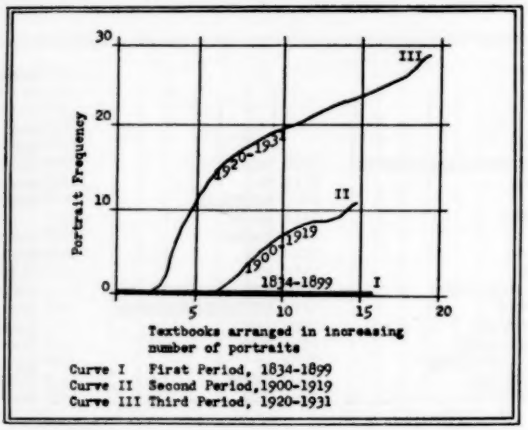

FIG. 3. Showing the Steadily Increasing Number of Portraits Appearing in Chemistry Textbooks.

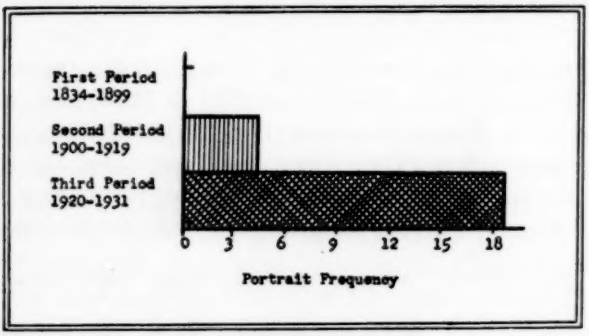

FIG. 4. Average Number of Portraits per Textbook During Three Periods of Years, 1834–1899, 1900–1919, 1920–1931.

rated in textbooks. In the fifteen texts edited prior to 1900, not a single portrait was used, whereas, a recently published text has a maximum of twenty-nine portraits. In the forty-eight books reviewed, biography was given for one hundred and eighty-six chemists. For some of the chemists, biography appeared only once; for others, twice, and so forth. Twenty-one

chemists (Fig. 5) whose biographies appeared most frequently were selected. The range from thirty-four to ten shows fairly well the relative importance of the chemists. Portrait frequency was considered for the same group of twenty-one chemists. Much irregularity is to be noted. However, Figures 1 to 5 indicate a marked tendency to increase the use of biographical data and of portraits in the newer textbooks.

The biographical material was catalogued under three headings, Vital Statistics, Outstanding Contributions and Items of Interest of Life History. These divisions were made on the basis of the questionnaire and a sampling of the material revealed that the kind of biography incorporated did not vary to any appreciable extent. Authors have given statistics very briefly

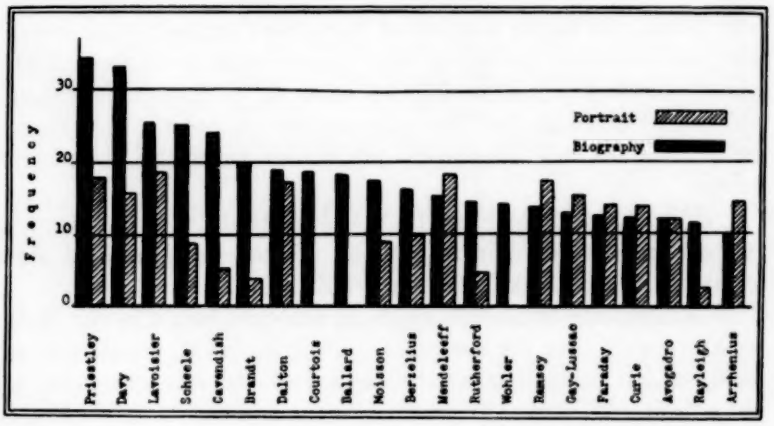

FIG. 5. Distribution of Biography and Portraits in Forty-eight Chemistry Textbooks.

concerning the makers of chemistry. Obviously, statistical matter holds little interest for the adolescent, because "To afford true mental stimulus it is necessary that the biographies themselves should possess life." (1) The age of hero-worship warms to those who have achieved.

In a revision of biographical data as suggested in the numerous replies to the questionnaire, for which lack of space precludes quoting, the size of the textbook must be kept in mind so that it does not become unwieldy. In actual point of space, eight or ten well-written biographies of the chemists, each to cover one printed page, opposite a full-page portrait, would take fewer pages in the text than the biographical material incorporated in the texts now in use. The author of the text

could devote two or three pages in the Appendix of his text to a table of statistical data of the many other scientists who have helped to make chemistry. In actual point of space, the pages devoted to the kind of biography suggested would not even aggregate that given in a scattered form in the forty-eight textbooks now under discussion. The data being evaluated in this study seem to point definitely to the fact that biography written primarily with a view to stimulate interest in the adolescent, would have definite pedagogical value in the chemistry text. At the same time by eliminating much of the statistical data as such, and substituting in its place biography written for the adolescent mind, much would be gained.

Conclusions

1. While the larger number of those who replied to the questionnaire favor a change in the biographical content of high school chemistry textbooks, because of pedagogical values which they attribute to biography for the adolescent, the minority do not exclude biography altogether from the chemistry course.

2. It was shown in Figs. 1, 2, 3, 4, 5, that there has been a general trend toward incorporation of more biographical material in the textbooks of recent publication.

3. A sampling of the biographical material found in the textbooks reveals that for the most part it is strictly statistical in form, which according to the replies of the questionnaire, is not a desirable form of biography for the adolescent. More stress on the Items of Interest of Life History seems to be desirable.

4. The weakness of the argument relative to the cost of printing suitable biography was shown through a comparison between the traditional "Statistics" which constitute the biographical content and the desirable form suitable for the adolescent. The change would involve no additional cost; contrariwise, the actual amount of printed material desirable would be less than the unsatisfactory form now being used.

5. Ends which may be derived from suitable biography are, first, cultural values for both teacher and student, stimulated by admiration for the splendid qualities of interest and endurance evident in scientific pursuits as recorded in biography; second, motivation fostered in the student whereby he may develop not only an understanding but also an appreciation of the scientific attitude and method.

6. The majority of educators to whom the questionnaire was sent, asked that biography in a form that would appeal to the adolescent, be made a part of the high school chemistry textbook.

7. Because of change in biographical content, textbooks may not be made unwieldy for classroom use.

8. Whether or not the judgment of the smaller group who replied to the questionnaire that they desire no change in biographical content of the text which they use, is based upon the same careful and critical attitude as the conclusion of the majority who ask for a change, remains a doubt in the mind of the writer. However, that is open for further research.

Constantly new editions of chemistry texts are being made available for the classroom. From the data presented would it not be possible to have authors embody several attractive biographies? It has been said that "Education is an eternal obligation which maturity owes to youth."(2) It seems, therefore, that an experiment along this line would not be too costly but on the other hand, prove beneficial to the youth who may thus become better acquainted with the Masters through the Ages.

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LEFTHANDEDNESS COMMONER AMONG BOYS THAN GIRLS

Lefthandedness is half again more frequent among boys than it is among girls, in a group of 7,651 school children observed by Dr. M. Schiller, city physician of Stuttgart, Germany. The average of "southpaws" for the whole group was 7.8 per cent., but there were 10 per cent of lefthanded boys, as against only 6.6 per cent of lefthanded girls.

Leftfootedness was much less common among the children. Dr. Schiller found only one per cent of them with this characteristic.

Lefthandedness is not observable among babies less than seven months old, the physician stated. Up to that age, the 900 infants she watched used right and left indifferently, with both hands and feet. Afterwards, preferential use of one hand and one foot (in most cases the right) developed spontaneously.

Since baseball is played very little in Germany, the remunerative career of "southpaw" pitcher is closed to lefthanded little boys. However, other roads to fame seem to be open to them: Dr. Schiller states that Goethe, Beethoven and Bismarck were all lefthanded.

SOME SUGGESTIONS IN THE STUDY OF INHERITANCE IN SECONDARY SCHOOLS

II. Chromosomes in plants and animals

By Lloyd W. Law
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In a preceding paper[1] there were given some suggestions for the use of genetic material in the laboratory or for demonstration purposes in biology courses in secondary schools, private schools, or possibly in junior colleges. Supplementing breeding experiments in plants and animals there should be introduced in any study of inheritance a brief survey of chromosome morphology and chromosome behavior. In fact, for a complete understanding of segregation and independent assortment of factors, as well as for illustrating the principle of dominance, it is imperative that pupils have a definite mental picture of chromosome structure and behavior. If secondary school pupils can see actual preparations being made to show chromosomes, and there is also available to them chromosome preparations clear enough and large enough, there will be developed a worth while appreciation of the mechanism of inheritance. Too often prepared slides demonstrate nothing clearly.

There has been developed in the last few years a new technique[2] in the study of chromosome structure and chromosome behavior, which can be used in making either temporary or permanent preparations. This involves the use of aceto-carmine solution which acts as a fixative and stain. In some cases better results are obtained if the material, chiefly root tips, is first fixed in alcohol-acetic solution (70 cc. of absolute alcohol to 30 cc. of glacial acetic acid) for from ten minutes to twenty-four hours.

Plants

The largest chromosomes in plants, 40μ in length, are obtained from Trillium, which can easily be grown in a green house. Some other plants which can be grown easily and which are quite suitable for chromosome demonstrations because of the ease of handling the material are Allium (onion) and Tradescantia (spiderwort). Tradescantia is especially good because

both root tips and young anthers can be used for obtaining mitotic and meiotic divisions respectively.

In order to obtain mitotic chromosome figures cut off the delicate root tip of the plant (about $\frac{1}{4}$ inch) and place in the aceto-alcohol fixative for at least ten minutes. Then, using a sharp knife or scalpel, slice the root tip in as small pieces as possible on a microscope slide. Crush, and add a few drops of aceto-carmine. In some cases for better results it is wise to add some iron-alum to the prepared aceto-carmine solution. A few cubic centimeters of 4% aqueous solution is sufficient. Allow the slide to stand for a few minutes, apply cover slip and heat gently. Then remove the excess aceto-carmine by pressing gently with a cloth or preferably with bibulous paper.

Meiotic chromosome figures can best be obtained from a plant such as Tradescantia. In Tradescantia it is best to collect the material for preparations before 10 A.M. during the summer months especially, however in some cases meiotic figures are obtainable at any time during the day. Remove the small buds on the inflorescence, open, and pick out the young anthers. Crush these on a slide, and add a drop or two of the aceto-carmine solution. Apply the cover slip and heat gently. The ellipsoid cells seen in these preparations are the pollen mother cells in the process of maturation. Only practice will give a clue as to what size buds are best in obtaining the desired figures. These preparations can be made semi-permanent by using paraffin or a mixture of paraffin and gum mastic (equal parts) around the edges of the cover glass. In order to further preserve the slides it is well to keep them in a cool, dark place.

Animals

The salivary glands of Drosophila offer very good material for chromosome study, especially as regards genic make-up. The average lengths of the chromosomes of the fruit fly as determined by Bridges[3] are—for the X chromosome 220μ, and for the second, third, and fourth chromosomes respectively 460μ, 485μ, and 15μ. In order to make preparations use larvae approaching the pupation period. Using a hand lens or preferably a dissecting microscope, slit the anterior part of the body open with a needle or very thin scalpel, and dissect out the glands, or if not certain about their structure, crush the anterior third of the larva on a slide, remove excess tissue, cover with a drop or two of aceto-carmine and proceed as above. Bridges

has found full grown larvae grown at low temperatures and from a new culture far superior to larvae from old or mass cultures in determining structural detail of the chromosomes. Practice in the use of the stain will enable one to see the banding on the chromosomes. It has been calculated that in the four chromosomes of Drosophila there are close to 3000 bands, each of which is thought to represent a gene, or the locus of a gene. This number is in close agreement with a calculation which estimates the total number of genes in Drosophila as from 1500 to 3000. The salivary chromosomes are so arranged and so paired that it is possible to see in some cases 16 small bands arranged in a linear order and representing 8 maternal and 8 paternal sets. It is supposed by some investigators that the genes themselves (estimated in size at from 20 to 80μ) are enclosed within these chromatic vesicular units. It might be mentioned here that all studies on chromosome structure and behavior should be done using an oil immersion lens and light coming from an artificial source filtering through a blue screen. The American Genetic Association at Washington, D. C. has a limited supply of very fine prepared Drosophila slides at a reasonable cost which are obtainable.

Grasshopper material is unique in that it offers a chance to see very clearly the chromatic bodies on the chromatids. The chromosomes are composed of chromatids with a surrounding matrix. The best stage for this study is late prophase (diplotene or pachytene). At this stage can be seen thread-like structures with numerous chromatic bodies of varied sizes arranged along them. These chromatic bodies, the chromomeres, can be seen to differ in size, and are arranged in a constant pattern in any given chromosome complement. These masses of chromatin material may represent sites of genes or in all probability of certain special reactions. Belling[4] has observed in the center of the chromomeres a dot which he regards as a gene.

These preparations can be made following the smear technique. Remove testes from a mature grasshopper, crush a small part on the slide, removing excess extraneous tissue, and proceed as outlined under Plants.

If in your temporary preparations you discover some that are particularly good which you wish to make permanent, this can be done in most cases with moderate success; however mitotic tissues offer difficulties chiefly because there is too much tissue on the slide which is easily washed off. The following

procedure may be followed. Place the slide, cover glass intact, in a solution of alcohol (absolute), glacial acetic acid, and xylol in equal proportions until the cover glass becomes loosened. Then transfer both slide and cover glass to a second jar containing alcohol and xylol in equal parts. Finally both to xylol, allowing a few minutes for each of the last two processes. Remove the slide and cover glass, add balsam, and re-apply the cover glass, so that as little material as possible is lost.

The aceto-carmine fixative-stain is prepared in the following manner. Add several grams of carmine (or an excess) to a mixture of 100 cc. of water and 100 cc. of glacial acetic acid. Bring the mixture to a boil, cool completely, and then filter. If the stain is not dark enough add a few cubic centimeters of 4% aqueous iron alum.

There has been presented in this paper and in a preceding one (breeding experiments with animals and plants) ample material for use in a study of inheritance. Some of the material may be incorporated in the regular laboratory program, whereas other suggestions will serve for demonstration purposes. It will be conceded that some of the material given is above the secondary school grade of work. Most secondary school instructors are probably content in teaching well the principle of dominance, the law of segregation, the applications of the laws of heredity. However for more mature pupils some of these suggestions can be used in the form of special problems and projects. It is hoped that possibly junior college and teachers college instructors will find some of this material useful.

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ERRATUM

In part I of the above article of the May issue
Suggestive crosses for illustrating segregation (1) should read
COLORED (C) ×albino (c)

AN ENDEAVOR TO CONTACT OBJECTIVES WITH METHOD IN THE TEACHING OF SCIENCE

By W. B. Buckham

San Leandro High School, Oakland, California

Are you one of the countless thousands who were able to withstand the trials of a year of senior high school science? If so, how much of it can you remember? Probably very little; especially if several years have elapsed since you last mixed chemicals or proved Boyle's Law by the methods prescribed in your laboratory manual recipe book. Is this as it should be? Is it right that all the benefits of this study should have faded into the complex blend which we call education for culture? Or do you think that you should remember some very definite facts, skills or attitudes, that you can recognize as direct results of your study?

The answers to these questions as given by recent writers on science teaching may be summarized briefly in the three following objectives for science teaching:

1. To develop a functional understanding of those generalizations of science which enable one to better interpret nature and invention and their effect on society.
2. To develop the attitudes of wonder at, respect for, curiosity about, open-mindedness toward, realization of the beauty in, and appreciation of—*the truth*, and its universal operation in natural law.
3. To establish the habit of using the scientific method of thinking in the solution of all problems.

This is a big order. It seems to include some generalizations which are consciously remembered as outcomes of science courses and some habitual feelings and patterns of behavior, which just grow like "Topsy."

If we accept the above to be valuable outcomes of science teaching the question at once arises as to how to attain them. To answer this question let us go back and consider how we came to realize that generalizations about nature, valuable feelings, and behavior patterns actually exist. Doubtless the cave man stumbled upon a few facts of science, but his attitude toward nature was probably one of fear. We have traveled a long road since then. How has our progress been brought about? The answer is self-evident. It has been by the patient work and thinking of the great scientists who have accumulated a tre-

mendous body of information about nature. While doing this work they caught the attitudes of science from their intimate contact with Nature, herself. They caught them neither by following printed laboratory instructions, nor by filling in blank spaces. They ran up against problems; blank walls which it sometimes took years to scale. Moreover, they evolved the best possible ladder for scaling these problem walls, namely the scientific method of thinking.

It is our duty as science teachers to short cut this experience of the great men of the past, so that it will function in the lives of the citizens of the future. Each person cannot be left to stumble upon it all by himself. The best of it has to be selected for him.

Obviously it is important to make the conditions in high school laboratories as nearly like the conditions in "real" laboratories as possible. In other words confront the student with interesting problems; show him the proper way to attack these problems; surround him with books full of facts to look up when he needs them, and tell him to go ahead. The function of the teacher then becomes that of guide rather than that of information dispenser.

Science lends itself readily to the use of two methods of teaching which together develop desirable social and individual attitudes and behavior patterns. They are the demonstration method and the laboratory method. Not that all other methods should be excluded, for they can be telescoped into the whole scheme whenever a need for them arises.

Much has been said by writers on science teaching in favor of the economy and efficiency of the demonstration method. All of which is doubtless true, as far as presenting facts is concerned. To demonstrate continually is to progress rapidly from one fact to another, so that in the end a great deal of ground has been covered. But, will all of these facts function? How much will they have changed the lives of the students who have sat through the hours of demonstration, when it is the nature of youth to be doing things? Interested they very well may have been, for new tricks of nature are always interesting, unless one becomes lost in the forest of too many dry facts. This has happened to many a student of science and may be partly responsible for the lack of interest in high school chemistry and physics.

The purpose of the demonstration method should be to pro-

vide a quick and easy way to present a new scientific principle necessary to the development of an important scientific generalization. Its ideal use should not be the covering of ground, but it may well be used to summarize for the purpose of pointing out a generalization. The give and take of an informal discussion accompanying a demonstration provides the situation for the development of certain social traits, such as the ability to contribute to, participate in, and make the necessary adjustment to, an organized group of persons. It provides an opportunity for the teacher to exhibit the scientific attitudes in an appealing way, and for the student to enrich his experience by explaining some special interest or demonstrating some special ability.

The student, having received the proper background from the demonstration, is now ready to over-learn the principle by applying it to the solution of problems in the laboratory. These should be problems with nothing but a blank piece of paper as a starting point: problems that at first sight seem blank walls, but which show footholds as one approaches nearer and seeks a means of climbing. The aim is to make school more like life, and the problems of life are not found in work books or recipe laboratory manuals. Do away with all recipes and blanks to be filled; substitute for them a thorough familiarity with the steps, procedures and tools, of the scientific method. Then, in marking the written reports on problems, place emphasis on the method of procedure as well as upon the facts recorded.

It is in the laboratory that the student gets the feel of the law of nature which he is studying. In the solution of several different problems he sees it function a sufficient number of times to make it part of his experience, and if the problems are chosen as nearly as possible from the students' environment, the chances of transfer to out-of-school activities are greatly increased. It is during this part of the work that the teacher has an opportunity to become acquainted individually with his pupils and to use this friendliness in passing on the proper attitudes and other influences Thus, in guiding the students through their difficulties with the intricacies of nature, the teacher has an exceptional opportunity to influence the character development of his students.

For a concrete example of the foregoing principles, suppose that it is desired to incorporated into the experience of the physics students, the mathematical relationship between the

original volume of a gas at atmospheric pressure and its diminished volume when subjected to an increase in pressure and vice versa, i.e. Boyle's Law. First comes the demonstration by the teacher. The idea of the compressibility of a gas is probably a part of the information of most of the pupils in a physics class. Yet it can be reviewed in a very simple way by pressing on the handle of a tire pump when the rubber outlet tube is closed. From that the teacher may turn to a closed J tube in which air is confined in the short end by mercury at the same level in each side. If the subject of air pressure has been previously studied, the class will easily grasp the idea that the air is confined at atmospheric pressure. They will be challenged by the question of how to increase the pressure on the confined gas and interested in watching its volume decrease as mercury is added to the long tube. If sufficient mercury is added to double the air pressure the volume will be cut in half. From there it is a simple step to the idea that $\frac{V^1}{V^2}=\frac{P^2}{P^1}$ or $\frac{2}{1}=\frac{152}{76}$. A good ending to the demonstration might be to have one of the students contribute, by presenting some of the interesting events in the life of Robert Boyle.

During the demonstration there should be a give and take discussion between the pupils and the teacher, based upon questions which arise in the minds of the students. Time should be allowed for the recording, in note books, of an outline of the discussion.

The next step is to provide an opportunity for the use of the principle presented in the demonstration. To do this the following set of laboratory problems could be given on the following day:

1. Prove that a gas is both compressible and elastic.
2. If the carbon dioxide gas confined in the cylinder placed in the front of the room, were allowed to escape into the room, it would expand to 100 cubic feet. Assuming that the temperature is the same, find the amount of gas confined in the cylinder.
3. By the use of Boyle's Law, calculate your lung pressure.

The first problem should be simple and of such a nature that all can readily do it. The first thing that the students should do is to look in their texts and other reference books to find suggestions. That, together with apparatus set out for their use

will enable them to hit upon several different ways of solving this problem. Some will blow up toy balloons and press in on the sides. Others will fasten a piece of rubber over the end of a thistle tube and pump air into it; while the best students will probably find an explanation of the Cartesian diver and realize its application to this problem. One who makes such a diver out of a hydrometer jar and a small inverted test tube partly filled with water, and has the fun of starting, stopping, or reversing that test tube at will by a slight variation in the pressure exerted on the rubber stretched over the top of the hydrometer jar, will remember that a gas is compressible and elastic much better than one who has merely watched the teacher do it. The sensation of successfully making a thing work goes a long way in making science real to a person. Consequently the value of the science laboratory.

Problem two should be more difficult. The students should begin by getting the problem clearly in mind. One way to do this is to write down what facts are given in the statement of the problem. This often leads to an understanding of the additional facts that are needed, and if it does not, the note book or reference book is always available in which to look for suggestions. A record may be made something like the following:

Given: 1. Volume in air and therefore at air pressure, $V' = 100$ cu. ft.
2. Volume in tank and therefore at tank pressure, $V'' = X$ cu. ft.

Find: 1. Air pressure by reading barometer and translating it into the units used on the pressure gauge on the tank $P' =$—— lbs. per sq in.
2. Pressure in tank by reading guage——$P'' =$—— lbs. sq. in.

It is supposed that on recognizing the fact that two different volumes and pressures for the same gas are mentioned in the problem, the student will recall the mathematical relationship between the different volumes and the pressures demonstrated the day before. Thus the use of the proportion is the next very evident step.

Problem three should be still more difficult and should constitute a real challenge to the brightest in the class. In this case everything is left to the ingenuity of the student. The only hint that he will find in his references will be the use of the closed monometer or J tube, which was used in the previous day's

demonstration. In thinking over the problem he will probably hit upon this idea, and the finding of such a piece of apparatus on the supply shelf will confirm this suggestion. He then should list the information which he needs to gather for use in the now familiar proportion.

Find: 1. Volume of confined air when water columns are equal $V' =$—— cm.
2. Pressure of V', by reading the barometer $P' =$—— g. per sq. cm.
3. Volume of confined air when I am blowing with all my strength——$V'' =$——cm.
4. Pressure exerted by my lungs $P'' = X$ g. per sq. cm.

The student is then again ready to use the proportion and often repeats the work two or three times to see if he cannot do better than his partner. In the process of working out the problem, the student will find it necessary to read the barometer, to use various metric units of measure as well as some simple algebra, all of which have been previously learned but are now being overlearned because of these additional chances to use them.

In order to gather in the loose ends, and make the laboratory work a finished product, some sort of a written report should be kept in a note book or handed in to the teacher. In either event each problem should be worked out by the teacher, in such a way that every student can see where he was right and where wrong. If these papers are graded, the habit of using the scientific method of thinking will be greatly enhanced by placing emphasis on the correct use of procedure was well as upon correct facts recorded.

Individual differences must of course be taken into account. If the sets of laboratory problems are arranged in the order of increasing difficulty, the first being simple enough for the slowest and the last hard enough to challenge the best students, all will experience the zest of accomplishment. Wherever individual interests make it possible for special projects, they should be encouraged in place of the regular work, by all means. Quite often students are content to work teacher-created problems, rather than take the trouble to initiate their own. Whether this is the result of the premium placed on passing subjects, together with other school practices which have been in use for many years, is a question which only new developments can answer.

A graduated point system based upon accomplishment can be

used to grade these experiments, if marks are desired, and most students seem to feel that they are. The difficulty lies in striking the correct balance between healthy challenge and unhealthy discouragement. To guard against the latter it might be legitimate for the teacher to slip a few points one way or the other, only, however, when it is positively undiscoverable by the students concerned. Is this last statement too sacrilegious to the god of objectivity, to be pedagogical?

In conclusion a summary of the suggestions that this article has endeavored to present may be helpful. First, the valuable principles and generalizations of science can be developed by demonstration and then made functional in the lives of students by having them solve a series of laboratory problems, in the solution of which the principles or generalizations are used. Each principle should be used many times, which means that science courses will have to be re-organized so as to contain less subject matter learned more thoroughly. A program of science, planned from the first grade through the high school, without unnecessary repetition, may be part of the new scheme. Also, problems must be chosen which are close to the student's environment, as this greatly increases the functioning of both the subject matter and the attitudes and habits.

Second, the scientific attitudes can be taught if the teacher possesses them, and provides opportunities which bring satisfaction as the result of the functioning of these attitudes.

Finally, the method of science can be made a habit by presenting it step by step to the class, and requiring the students to follow it in the solution of each problem. This will call for emphasis in marking, on the procedure used in solving a problem, as well as on the correctness of the facts recorded.

There isn't much that is new in the suggestions made above. Perhaps you have been following this method. Is it workable or is it not? Only trial and testing can answer this question. Testing not only for facts learned, but also for functioning generalizations, attitudes and habits. And so arises again the ever present need for experimentation by the ever busy teacher, who needs all available time and energy to keep those thirty or more youngsters busy for nearly an hour a day. That in itself is a task.

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THE ORGANIZATION OF HIGH SCHOOL BIOLOGY ON THE PROBLEM BASIS

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In a previous article, (see October, 1935, School Science and Mathematics), I discussed the organization of Biology on the seasonal basis. I wish to further develop the organization of Biology so that it may become a series of problems to the High School student. If these problems are to be real problems rather than artificial ones, they must be difficult enough so that he will not immediately guess the results. If they are to be interesting, they must be within his own experiences. If they are to be challenging, they must be presented to him in need of solution. The problems may consist of experimental work, careful observations, checking of data, as well as confirmation of results by the use of the text-book and other sources of authority.

If the student is to be made to feel that he is making progress in the acquiring of knowledge and skill, the problems should be so arranged that the information gained from one experiment is used in the next problem. The arrangement should be continuous and consecutive. Each individual problem should be a part of a greater problem or understanding toward which the entire course leads. The beginning of every problem should be in a natural setting or a life-situation. The solution of each problem should have some definite contribution to an understanding of life as it exists in the great out-of-doors or in the modern conditions under which man works and lives.

All problems should have some definite value culturally or economically, and this value should be stressed in the problem. There is too much useful material to crowd into a course in Biology that busy work need never be introduced. Counting the number of spiracles on the abdominal segments of a grasshopper may be an interesting pastime, but some reason for knowing that the grasshopper breathes through spiracles rather than through a nasal opening, would be more useful information. The incentive for many problems may be the desire to know how the organism lives and carries on its life-processes, to know the Laws of Nature so that we may work with them rather than in ignorance of them, to know the Truth with the

hope that the Truth will make us free. It will make us free from ignorance and superstition.

As far as possible, the dominant interest of the student at the particular time of the year should be followed. Not the incidental but the purposeful plan of seasonal changes which are taking place in all living things should form the framework on which the course is built. Such things as the coloration of leaves, the migration of birds, the spawning of fish, the blooming of wild flowers and many more of the phenomena of living things that take place seasonally are but a few examples of seasonal reactions of living things. By following the seasonal method, the use of specimens preserved in formaldehyde will seldom be necessary. Some artificial plan for holding the course together will not be necessary. If the environment is not present for the solution of the particular problem, some other problem should be substituted in its place. Living things brought to the laboratory and kept for observation will be necessary rather than an incidental part of the course.

In so far as these suggested problems fall short of the above-named objectives, they need to be revised, corrected, or substituted by other problems. Only by experience does the student learn. By giving the student the experiences with living things in his own environment with the opportunity to study and interpret the activities, the teacher of Biology is doing what one great educator has suggested, "Help the student to do better the things he will do anyway."

In this plan of organization, one process is not separated from all other processes in that individual as they are all interrelated and interdependent. There is always the emphasis on Biological Principles which the living organism illustrates. "How does the organism solve its life-problems?" is the chief point of emphasis, rather than using the organism to illustrate different types of processes vaguely held together by an artificial set-up. There is always the emphasis on physiology rather than on anatomy, on function rather than on form.

The following list of suggested problems will need to be changed somewhat in order of study to suit different environments. Some of the problems may be entirely omitted and others substituted in their stead. In order to save space, the statement is made very brief.

1. What seems to be the most abundant form of life everywhere?

Make a list of living things observed on vacant lot, old garden, woods, prairie, park, stream, field.

Simply try to determine which ranks first as birds, flowers, trees, weeds, insects, in number of forms.

Results will differ as to time of day, weather, and place visited, but usually the insects will win. There are more known species of insects than all other forms of life combined. Check for this.

2. Is there food competition between the various plants and animals?

Do all succeed equally well in all kinds of places?

Which succeed best in yards? Which in waste places?

Try to discover why some succeed better one place than in another.

Which ones of our domestic plants and animals would succeed best if left to themselves? Which would probably disappear first?

How does man preserve the kinds of plants and animals he prefers?

3. What seem to be some of the most common enemies of our domestic plants and animals?

Suppose we start with the insects. Let us find if there is an insect enemy of every plant and animal.

Make a list of insect enemies of some common plants as our fruit trees, garden vegetables, wheat, corn, cotton, flowers. Collect specimens and watch them feed on the plants of our garden or field. Use lamp chimney covered with cheesecloth over plants which insects eat.

Try to discover some of the farmer's crops, fruit, garden, etc., that were destroyed or partly so during the past season and determine the amount of damage. Make an estimate of the County damage, State damage, and National damage.

Make a laboratory study of one of the common insects, as the grasshopper. How does it eat, breathe, walk, jump, fly, etc.? How is it protected? How does it reproduce?

By the use of references, try to find some of the most common methods of holding in check the insects studied.

4. What are some insects that are carnivorous and therefore help to hold in check other insects?

Place praying mantis and grasshopper in same jar. What happens?

Place lady-bird beetle in test tube with some plant lice. How many will be eaten in one night?

Try ground beetles, stag beetles, tiger beetle, or other carnivorous beetles in bottle with other insects.

Make a list of the carnivorous insects with their victims. How has the introduction of carnivorous insects aided the farmer?

5. How are the insects adapted to their environment? How are their special senses developed?

Study the eye of grasshopper under microscope.

Try to find the ear of grasshopper, cricket, katydid, cicada.

By what means does the cricket chirp, katydid sing, cicada make such a loud noise?

Try to discover how the Viceroy butterfly is protected by mimicry of the Monarch butterfly in color.

How does protective coloration help certain moths?

How does migration of the Monarch butterfly protect it?

How does the exoskeleton of insects protect them?

How are certain insects protected in the winter time?

6. What are some commonly used insecticides?

Why will Paris green or lead arsenate kill certain insects but not others?

Why are contact poisons as nicotine-sulfate, oil-emulsion, or lime-sulfur used for certain insects?

Why does the kind of mouth-parts determine the kind of insect spray to use?

7. What are some effective methods of fighting the mosquito?

Secure eggs and let them hatch into wiggle-tails.

Watch the feeding of wiggle-tail or larva, also breathing, growing, movements. (Use compound microscope.) Continue until the pupa stage. Watch change in breathing tube, movement.

Place mosquito-bar netting over jar and allow them to emerge as adults. Study mouth-parts.

Try killing larvae by placing kerosene or oil on water.

If available, secure some Gambusia fish and place in jar with larvae. These small tropical fish made possible the Panama Canal. How?

How has knowing the life-history of the mosquito helped in eradicating it?

How has the disease-carrying mosquito been held in check in the tropics?

8. How is the honey-bee fitted to do its work?

Secure all stages of the honey-bee. Place under jar with some honey and observe.

How is the mouth fitted for taking nectar from flowers?

How are the legs fitted for carrying pollen?

How do the wax-plates help in making beeswax?

How is the ovipositor modified into the sting? Where is the poison sac? Why cannot the male sting?

Why cannot the male carry honey? Why called the drone?

What are some relatives of the bee? How does the ant differ from the bee? Why are they placed in the same general group?

9. What are some problems relating to our food supply?

Try to analyze the production of food, its preservation, distribution, etc.

Select a typical kind of food as bread. Trace the origin of the food to the wheat plant.

What part of the wheat plant makes its food? Where is the food stored?

Show the dependence of animals on the plants for food.

10. What are the things necessary for a plant to make food?

Is light necessary? Cover a part of a leaf. After a few days, test the leaf by boiling out chlorophyll in alcohol, then testing with iodine.

Is chlorophyll necessary? Use a leaf of Coleus or other plant with white places. Test with iodine.

Is carbon dioxide necessary? Keep all carbon dioxide from leaf by drawing air through lime water which removes carbon dioxide.

Does a leaf give off oxygen in making food? Use a leaf of water plant which gives off bubbles in making food. Test air for oxygen.

11. How is the structure of the leaf especially fitted for food manufacture?

Examine the epidermis of the leaf for stomata for the entrance of carbon dioxide and the elimination of oxygen and water.

Study the cross section of the leaf cut very thin under the microscope. Look for food-making parts.

How is the manufactured food carried to other parts of the plant? Examine the cross section of vein of leaf.

12. What are some things which a plant secures from the soil for food manufacture? 1st water.

How does a plant secure its water from the soil? Use osmosis experiment with egg in water or thistle tube with membrane.

Grow radish seedling in culture dish to show root hairs and how they extend the absorbing surface of the root.

How does a plant give off some of its water into the air? Cover plant with bell jar and observe the water accumulating on the inside of the bell jar. 2nd minerals.

Grow corn or other seedlings in water that has certain chemical elements missing as nitrogen, magnesium, calcium, iron, sulphur, phosphorus.

How does the soil water carry these minerals to the plant? Show diffusion of potassium permanganate in water.

13. What parts of the plant serve as places for the storage of food?

Get a list of plants that store food in the roots, as carrots, turnips, sweet potatoes, etc. Secure plants where possible.

Make a list of plants that store food in stems, as the white potato (underground stem), asparagus, sugar-cane, etc.

Make a list of plants that store food in leaves as cabbage, lettuce, spinach, cactus, etc.

Make a list of plants that store food in seeds. Test for kinds of food stored in beans, corn, wheat, etc.

14. What kinds of food are stored in plants?

Make test for starch with iodine.

Make test for protein by xantho-proteic test.

Make test for fat by oil-paper test.

By use of references, what vitamins are known to be found in plants?

15. How is the food stored in the seed of the plant used in growth?

Grow seedlings of corn and beans. Test sprouted seeds for sugar.

What parts of the seed become parts of the new plant?

Study the growth of roots, stem, and leaves from the seed.

Review the use of each to the plant. What other uses can you now find?

If time permits, make a study of some of the common stems of plants that are useful to us, as trees, etc.

How may the various kinds of leaves be used for identification of trees?

16. How do plants prepare for winter?

Study different leaves of deciduous and evergreen trees.

Note coloration and fall of leaves, protection of buds, etc.

This unit should be studied at the time when coloration of

leaves begins. A collection of leaves for getting acquainted with trees should be made.

17. How is the food stored in the seeds of plants used by us for food?

Observe that most of the food of the world is stored for the young. (Plants in seeds, animals in eggs, milk, etc.)

How is the mouth fitted for digestion? Observe teeth, tongue, saliva. Test effect of saliva on starch. Use Fehling's solution to test for digested starch.

How is the stomach fitted for digestion? Test for protein digestion by pepsin, curdling of milk by rennin, softening of bone by hydrochloric acid. Examine pig stomach for muscular and glandular walls, cardiac and pyloric valves, etc.

How is the small intestine fitted for digestion? Test effect of pancreatic juice on starch, protein, and fat. Test effect of bile on fat. Observe the villi of intestine of pig.

18. How does the digested food get to the various parts of the human body where it is used by the cells of the body for energy and growth?

How is the small intestine fitted for its work of absorption of food? (villi)

How is the liver fitted for its storage of glycogen or animal carbohydrate food? How does it reach the circulation?

How are the lacteals fitted for fat absorption? How do they carry the fat to the body cells?

How can protein food reach the body-parts by the blood stream?

Study the heart of the pig or calf to see how it is fitted for its work of pumping the blood. Trace the circulation.

19. How does the body secure its energy from the food? Where in the body does the energy-release take place? What part has oxygen in this energy-release? How does the body secure its oxygen?

Since the energy-release must take place in the cells, tell how oxygen reaches the cells.

Study the lungs, trachea, and bronchial tubes of the pig or calf.

How does the oxygen of the air exchange places with the carbon dioxide of the lungs?

Show by the experiment that the lungs take part of the oxygen of the air, by burning candle in quart jar of ordinary air and air expelled from the lungs. Time in seconds.

Show that carbon dioxide is expelled from the lungs by blowing breath in lime water.

Trace the path of the pulmonary circulation.

20. How does the body rid itself of the wastes of food metabolism?

The lungs carry off carbon dioxide (previous problem).

The skin carries off poisons and helps regulate heat by perspiration.

The kidneys throw off urea. References of urinalysis.

The large intestines carry off wastes. Read advertising of cathartics. Toxic effect of improper elimination is a frequent cause of colds, headaches, etc.

Selection of food for bulk is very important. Why?

21. How does the body use the protein food for growth into body tissues?

What are the kinds of body tissues—bone, muscle, nerve, epidermal tissue, etc.?

Observe the human skeleton for kinds of joints, ligaments, tendons, attachment of muscles.

Study various kinds of tissue of the pig or calf, as striated and non-striated muscle, cardiac muscle, fatty tissue, epidermal tissue, protective tissue.

Study the blood as a tissue, noting red and white corpuscle fibrin, plasma, etc.

22. How is the body kept under control?

Study the brain and spinal cord of the pig or calf.

Study the nerve cell and nerve ganglion.

By use of drawings, study the sympathetic nervous system.

What is the autonomic system? What is its use to the body?

23. How is man made aware of his environment?

Study the eye—How made, protected, focused, sense of sight. Use model, drawings, lens, etc. Optic nerve.

Study the ear—How it receives sound waves, converts them into sensations and carries them to the brain.

Study senses of touch, taste, and smell. Test these special senses experimentally.

How do the special senses serve man?

BEGINNING OF SECOND SEMESTER

24. How does the compound microscope aid the Biologist?

By use of references, study the contribution of Leeuwenhoek to the microscope.

By the use of the compound microscope, study some simple plant as the Pleurococcus, or yeast. Prepare hay-infusion. Study Protozoans as Paramoecium, Vorticella, etc.

25. How has the microscope aided man in discovering disease germs?

Study of the hay-infusion for presence of bacteria. Identify various shapes of bacteria.

Identify certain bacteria which cause diseases of man as the typhoid, tetanus, tuberculosis, and other bacteria from prepared slides.

Identify certain Protozoans that cause disease, as the malarial parasite. Review what you learned about the mosquito and this disease in problem 7.

26. What are some of the common places where bacteria are found?

Prepare cultures of agar-agar and beef bouillon. Place agar-agar in culture dishes or test tubes. Place beef broth in test tubes. Sterilize both.

Expose culture dishes to dust particles, fingers, hair, milk, breath by coughing, etc.

Observe growth of bacteria on culture from day to day.

27. What are some common ways of preventing the growth of bacteria?

Use beef broth in test tubes to test the effectiveness of various preservatives to prevent growth of bacteria. Salt, sugar, pepper, vinegar, salicylic acid, etc.

Test the effectiveness of certain disinfectants in preventing bacterial growth. Test with iodine, mercurochrome, Listerine, S.T.37, Vick's nose drops, etc.

How does drying prevent bacterial growth? Refrigeration? Canning with pressure cooker?

Is there such a thing as spontaneous generation? How can you prove your answer? What part did Louis Pasteur take in the early controversy?

28. Who have been some of the greatest Microbe Hunters?

What have been the contributions of Sir Joseph Lister, Edward Jenner, Koch, Reed, Pasteur, Leeuwenhoek, and others?

What method is used to determine the bacteria which causes a certain disease?

What are some of the ways in which man has been made more free from diseases?

What is natural immunity? What natural protection has man against bacteria?

29. How do plants without chlorophyll secure their food?

Study the yeast plant. Why must it be fed? How does it reproduce? By the use of fermentation-tubes, tell under what conditions of food and temperature it grows best.

Study the bread mold. How does it grow? How reproduce?

How does this information assist us in holding in check undesirable plants?

How may it help us to grow desirable plants?

30. What are some ways by which plants reproduce?

Secure some moss plants with the sporophyte generation and gametophyte generation both on the same plant.

Compare this with the fern plant. By the use of charts, study the life-history of the fern.

Secure the pine cone. Compare its reproduction with the moss and fern.

31. How does the flower aid in reproduction in the higher plants?

Secure the first wild flower available for class study.

Study its method of pollination.

By the use of references, study fertilization. Why is fertilization necessary? Compare mitosis with meiosis.

32. What are some ways in which animals reproduce their young?

Review the study of the Paramoecium and Vorticella.

Secure some Hydra and study for methods of reproduction.

How does the earthworm reproduce? Study food getting, movements, securing of oxygen, circulation, etc.

How does the clam, snail, or slug reproduce? Study other life processes necessary to success as animals.

How does the crayfish reproduce? Find female with eggs under telson. Study other life-processes of crayfish.

Why do spiders succeed? Which are poisonous? How do they carry on life-processes?

Review the insect and secure some insects that were not found in the fall. Watch them molt and carry on other life-processes in the spring.

33. How do higher animals reproduce?

Find fish eggs. If necessary, remove from female fish. Study other processes of fish that make it succeed. How does it secure oxygen, food, escape enemies, etc.?

Find frog eggs. Watch them emerge in the laboratory into tadpoles. Observe development from day to day. Study the frog as to other life-processes.

Find examples of the reptiles, the turtles and snakes. If possible, secure eggs. Study development.

34. What are some interesting and important things we may learn about birds?

This unit should be continuous from the first returning migrant in the spring. Keep a bird record.

Why do birds migrate? Watch nest-building and egg-laying.

Use the hen egg to study the embryo of the chick. Incubate for one day, two days, etc., and study developing embryo.

In what ways do birds differ from other animals studied?

35. What are some things we should know about the mammals?

Use the rabbit as an example of the mammal. How does it reproduce? What differences in reproduction in the opossum?

Have in the classroom a mother rabbit and young, white rat, Guinea Pig, or other mammal. Why are they called mammals?

36. What are some things we can learn about reproduction in flowers?

Begin this unit with the first flower in the spring.

Have brought to class for study the different types of flowers.

What are some methods of pollination?

Review what was learned about fertilization.

Make a study of Gregor Mendel and his experiments on the garden pea. What were some of the things he learned?

37. What are some of the laws of heredity? How may they aid us in understanding our own heredity?

By the use of references, study the family-history of the Jukes and Kallikaks. What undesirable traits seem to be inherited?

Study the family-history of the Edwards Family. What desirable traits seem to be inherited?

What is Eugenics? How is it trying to improve the human race?

What is Euthenics? How is it trying to improve the human race? Which seems to be more important? Eugenics, or Euthenics?

What are some things which High School boys and girls should know for their own good about their own heredity?

In conclusion, it should be stated that the above units or problems are about equally divided between the fields of study of Biology including plant study, animal study, and study of man.

Problems 1–9 relate to our Food Supply.

Problems 10–16 relate to food manufacture and storage.

Problems 17–23 relate to food digestion and use by the body.

Problems 24–28 relate to health and the prevention of disease.

Problems 29–31 relate to reproduction in plants.

Problems 32–35 relate to reproduction in animals.

Problems 36–37 relate to heredity and eugenics.

The entire first semester relates to Nutrition and Foods. The second semester relates to Reproduction and Heredity. To state this in another way, the first semester is a study of how the individual maintains itself, the second is a study of how the species maintains itself. In general, the second semester follows the Evolutionary plan of organization.

When the seasonal plan of organization of Biology was introduced into Tulsa Central High School, there were 356 students enrolled in Biology. In two years, this number had increased to 621 by the voluntary enrollment of students. The entire enrollment of Science gained from 977 to 1192 students, a gain of 225 students. The gain in Biology was 265, or 74%. The total gain of 225 students showed an actual loss in other Science courses. To offset this rapid drift to Biology, a course in Physical Science was introduced to integrate the work in Physics and Chemistry. This course became very popular and soon took the extra enrollment.

While it is not entirely safe to judge the value of a course by the enrollment of students in it, it has some indication of the value which students attribute to it.

PROTECTION FROM RAYS

The vast drive of physicists in the last few years to learn more about the secrets held within the cores of atoms has resulted in a new influx of radiation burns caused by X-rays and the radioactive substances, either natural or artificial, with which these explorers of the atom must work.

This knowledge and a suggestion of ways in which scientists can guard against such piercing radiation was presented to the American Physical Society by Dr. G. Failla, chief physicist of Memorial Hospital, New York City, where—for years—radium and X-rays have been used for the treatment of cancer and its allied diseases.

In its way the new increase in radiation burns is similar to the havoc wrought in the early days at the start of the century when X-ray and radium rays were first being used for experiment and therapy, except that the latest increase comes when the scientists supposedly have full knowledge of the dangers they face in such atomic research.

PUPILS' ABILITY TO GENERALIZE*

By W. C. Croxton
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Our elementary science work has been based on the assumption that childhood is a time for developing interests in nature, obtaining rich emotional satisfaction, and acquiring a fund of information through environmental contacts. Principles and generalizations have been given a more incidental place, the usual consideration being that they belong more naturally to the high school and college levels.

Within the past few years a strong movement has grown to direct the science work throughout the schools toward comprehension of broader generalizations together with development of concomitant attitudes, skills, and appreciations. This movement has found expression in Part I of the Thirty-first Yearbook of the National Society for the Study of Education, in numerous recent articles, science readers, and courses of study.

This viewpoint has not been universally accepted, however, and is one of the chief matters of discussion and study in the field at the present time. There is not time here to review the literature, but the essence of certain opposing viewpoints may be stated. On the one hand, directing science work toward understanding of principles, which in turn are the essential contributing elements for broader generalizations, finds support on the ground that it will give purpose to otherwise aimless and desultory science teaching, guide us in the training of teachers, and serve as a basis for critical evaluation and much needed revision of syllabi. On the other hand, the question has been raised as to whether such a program of science education is psychologically sound. A number of workers have expressed the view that elementary pupils are absorbed in attaining emotional satisfactions, that generalization is a somewhat unnatural process at this period, and that forcing processes must be resorted to in attempting to develop generalizations at this age, with the outcomes of little value in child development.

The question at issue simmers down to this. Is the failure of children to generalize due primarily to lack of this power or tendency, or is it simply due to want of a sufficient experience basis for generalization? Relatively few studies of the ability of children to generalize have appeared, and we are forced to

* Address before the American Science Teachers' Association in St. Louis, January 2, 1936.

admit that we do not have the answer to this question so basic to the present problem of elementary science education.

I am under no delusion that the preliminary studies of pupils' ability to generalize here reported answer this question or afford the needed guidance. They possess too many limitations and the data are altogether too restricted to permit any conclusions warranting wide application. Perhaps they may stimulate consideration of the problem, and indicate certain hypotheses which further investigation will test.

The first two of these experiments were carried on eight years ago in the Riverview School of the State Teachers College. Three additional experiments were undertaken during the present year in the Riverview School and in two of the elementary schools of the city. The purpose of these experiments was to discover whether children in the various grades are able to generalize readily without explanation by the teacher. More specifically, most of the experiments tested the pupils' ability to formulate and apply a principle after eight minutes exposure to the essential experience basis in the form of demonstration or directed play. The total time in each room was fifteen minutes. Occasionally in the lower grades it was necessary to extend the recording time slightly. The experiments were all carried on by the author, using room teachers and student teachers to assist. In the kindergarten and first two grades the children reported to recorders stationed about the room. Children above these grades wrote their generalizations and answers to application questions.

In the first experiment live animals (guinea pig, salamander, fish, canary, toad, water beetle) were placed on one end of a table. Potted plants (cactus, Jerusalem cherry in fruit, Narcissus in bloom, Cyclamen in bloom, Coleus with variegated foliage, palm) were placed at the other end of the table. The pupils in each room gathered about the table. The experimenter desig-

TABLE 1

GENERALIZATION—COMPARISON OF PLANTS AND ANIMALS
Average Number of Generalizations Per Pupil

Kdg.	I	II	III	IV	V	VI	VII	VIII
.31	1.11	1.09	2.39	2.42	2.44	2.63	3.10	4.00

nated the two groups as animals and plants, naming each animal and plant. The pupils repeated the names and were left

free to observe and play with the plants and animals during the experience period. They were then asked to state as many ways as possible in which all of the animals on the table were different from all of the plants. Table 1 shows the average number of correct generalizations per pupil in each grade. Generalization in the kindergarten dealt only with movement and color. The range as well as the number of generalizations tended to increase throughout the grades. The method of recording probably tended to reduce the number of generalizations below the third grade. Intelligent generalizations were formulated in all grades. In the kindergarten and to a lesser extent in the lower grades many statements concerned a single animal or plant. Examples were, "Guinea pig is eating," "The salamander is real long and can crawl." Most of the other statements marked incorrect showed failure to take into consideration all of the plants or animals.

In the second experiment, a series of paired pendulums hung from a frame work made of jointed gas pipe was used. The pendulums consisted of strings of different lengths to which light and heavy weights were attached. They were paired as follows: equal length and different weight, different length and equal weight, long string with light weight and short string with heavy weight, long string with heavy weight and short string with light weight. The children were asked if they would like to have the pendulums run races. The pupils were divided into two groups. Each group counted the number of swings made by one of the paired pendulums until the experimenter stopped them. The results were then announced without further comment. At the end of the experience period, the experimenter

TABLE 2
GENERALIZATION—SIMPLE PENDULUM PRINCIPLE

Grade	*No. Pupils*	*% Generalize*	*% Apply*	*% Generalize and Apply*
Kdg.				
I				
II				
III	24	76	76	42
IV	21	48	76	48
V	27	78	52	48
VI	32	84	78	68
VII	20	25	50	20
VIII	22	36	27	27

asked, "What makes the pendulum go slow or fast?" After the generalizations were recorded, the following application question was asked, "If your clock were losing time and causing you to be late for school, what could you do to the pendulum to make it run faster? Would you make it heavier, lighter, shorter, or longer?" Table II shows the percentage of pupils in each grade correct in generalization, in application, and in both.

The data for the kindergarten and first two grades are not included in Table 2, as sufficient precautions were not taken to credit the application and generalization to the same pupil in all cases. Not all of the pupils in these grades responded. Of the responses received, 14% in the kindergarten, 24% in the first grade, and 47% in the second grade were correct as to generalization. The corresponding percentages for application were 11%, 40%, and 58%. Various hypotheses might be advanced for the marked drop in the scores in the seventh and eighth grades, but the results of subsequent experiments as shown in Tables 3, 4, 5, and 6 do not indicate that this condition is general.

The third experiment was designed to test the ability to formulate and apply the generalization that warm air rises and cold air sinks. The experimenter first called attention to the fact that by watching the direction taken by smoke issuing from chimneys, one can tell which way the air is moving. He then exhibited a bee smoker stating that the smoke would enable the pupils to follow the air movements. Children then came up to examine apparatus consisting of a kerosene lamp and a stack of tin cans filled with ice. They felt the cold cans and held their hands over the lighted lamp. Long cylindrical shades of tag board were then placed about the lamp and the stack of cans, and supported on wire frames. Smoke was then puffed in through a small hole in each shade. The pupils watched it issue forth. Smoke was also puffed against the heated radiators and the cold windows. These processes were repeated several times during the experience period. The generalization question was then asked, "What does this show about warm air and about cold air?" To test the application of the generalization pupils were then asked, "Does this mean that the air is warmest in this room near the floor, near the ceiling, or at about the height of your head?" The results are shown in Table 3.

For the fourth experiment, six toy balanced teeters about two feet in length were constructed. With each teeter four weights

TABLE 3
GENERALIZATION—WARM AIR RISES, COLD AIR SINKS

Grade	*Pupils*	*% Generalize*	*% Apply*	*% Generalize and Apply*
Kdg.	65	15	45	11
I	64	23	48	8
II	64	59	47	29
III	54	46	46	17
IV	65	71	37	31
V	62	71	48	35
VI	72	83	61	54
VII	22	95	91	86
VIII	19	79	74	63
IX	20	55	80	50
Opp. Room I	9	67	67	33
Opp. Room II	12	50	83	50

(200, 100, 50, and 10 grams) were supplied. To further the play spirit, the knob of each weight was dressed to represent a boy. Pupils were divided in equal groups about the teeters. The experimenter explained that the point of the game was to see how many ways the teeter could be balanced using only two weights at a time. Assistants saw that all children in the group participated in turn, but allowed other children to make suggestions at all times. At the end of the experience period, the question asked was, "How do you always make the teeter balance?" To test application of the generalization, children were given sheets of paper on which two teeters were dia-

TABLE 4
GENERALIZATION—PRINCIPLE OF BALANCE

Grade	*Pupils*	*% Generalize*	*% Apply*	*% Generalize and Apply*
Kdg.	51	0	6	0
I	65	12	22	6
II	55	21	35	16
III	56	16	34	11
IV	65	42	40	26
V	62	47	63	39
VI	73	44	64	30
VII	21	62	67	53
VIII	17	65	76	65
IX	21	38	67	29
Opp. I	7	0	29	0
Opp. II	10	70	50	30

grammed with a weight half way out on one arm of each. The pupils then assembled about one of the teeters. The experimenter placed the four boys (weights) in a row calling attention once more to their order of size. He then discarded the smallest, and placed the hundred gram weight half way out on one arm as indicated on the sheets distributed to the pupils. He then picked up the next smaller boy (weight) and asked the pupils to place an X on the first diagram at the proper place to make the teeter balance. This was repeated using the largest weight and recorded in like manner on the second diagram. In Table 4 only those pupils are credited with applying the generalization who marked both diagrams correctly.

In the fifth experiment, a series of animals was arranged on a long low table in the following order; butterflies in a Riker mount, live fishes in an aquarium, live frogs, live turtles, a mounted Bull snake, mounted birds (Chinese pheasant, Brown Creeper, Cooper's hawk, Scarlet Tanager, Mallard duck), a mounted weasel in winter fur, a mounted muskrat, and a mounted bat. The experimenter stood at the end of the table and explained his similarity to the other animals until the pupils agreed that he was also an animal, although an occasional child interjected the qualification that he was a human animal. The experimenter then touched each animal in turn asking the pupils to examine and state aloud how many wings it had. The process was repeated asking in turn the covering, the coloration, and the number of legs possessed by each animal. The experimenter

TABLE 5

GENERALIZATION—CHARACTERISTICS COMMON TO BIRDS

Grade	*Pupils*	*% Generalize*	*% Apply*	*% Generalize and Apply*
Kdg.	66	12	5	0
I	59	27	5	0
II	53	42	15	6
III	55	44	35	27
IV	72	60	35	22
V	68	62	49	35
VI	69	42	54	28
VII	22	77	55	45
VIII	19	84	68	68
IX	21	76	52	43
Opp. I	14	36	14	14
Opp. II	13	85	54	38

then grouped the birds at the center of the table, designated them as such, and asked, "How can you tell the birds from all of the other animals on the table? Three application questions were subsequently asked for which yes or no answers were recorded. 1. "Are all animals that have wings, birds?" 2. "Are all animals that have feathers, birds?" 3. "Are all animals that stand on two legs, birds?" Only those pupils who answered all three questions correctly were credited with the application. The results which appear in Table 5 indicate something of the ability of pupils in the different grades to sort the data and select common elements for a generalization.

In order to reduce the effect of variable factors in so far as possible, the results of the last four experiments were compiled in a summary in Table 6.

TABLE 6
SUMMARY OF FOUR GENERALIZATION EXPERIMENTS

Grade	*Pupils*	*% Generalize*	*% Apply*	*% Generalize and Apply*
Kdg.	182	10	14	7
I	188	21	26	5
II	172	43	33	18
III	189	40	43	21
IV	223	57	44	28
V	219	62	53	38
VI	246	61	62	41
VII	85	65	66	51
VIII	77	65	60	55
IX	62	58	66	40
Opp. I	30	37	33	17
Opp. II	35	69	63	40

The average chance factor in the application score for the four experiments shown in the summary table is approximately 24%. The chance coincidence of correct generalization and application is almost negligible.

In interpreting these experiments, it is necessary to realize that they afforded a rather meagre experience basis for generalization. No explanations, discussions, or individual aid were given. In this manner there should be relatively little repetition of statements without grasp of ideas. It ought to be possible with more time and the encouragement and help of a skillful teacher to secure a much higher percentage of correct generalizations and applications than were obtained in these experi-

ments. While the following conclusions are suggested by these experiments, it cannot be too strongly emphasized that they are only suggestive or, at best, highly tentative.

Tentative Conclusions

1. These data indicate that many children in the higher primary, the intermediate, and the junior high school grades are capable of generalizing.

2. While the experiments do not prove that most pupils in the kindergarten and lower primary grades could not generalize if a more adequate experience basis were provided, the data together with the evident obsession manifested by these children for obtaining emotional satisfaction do suggest that early childhood is preëminently a period for satisfying interactions.

3. There is little in these experiments to indicate that junior high school pupils possess markedly superior ability to generalize than intermediate grade pupils possess, the difference in scores in favor of the former being little more than might reasonably be credited to added experience. The fact that this superiority manifested itself in more consistently applying their generalization leaves this matter in doubt, however.

4. The scores of the pupils in the opportunity rooms indicate that other reasons than subnormal ability to generalize enters into their classification. It will be noted that the scores of the children in Opportunity Room I, most of whom are rated below IQ 70, are about equal to those of children in the second grade. On the other hand, the score of pupils in Opportunity Room II compare rather favorably with those of junior high school pupils. However, the numbers involved are too small to make the findings of special significance.

15,000,000-YEAR-OLD FOSSILS

A notable find of fossils has been reported from the region of Lake Balkash in Kazakstan, near the Mongolian border. Especially noteworthy are skeletal remains of Moropus, a "missing-link" animal, between horse and rhinoceros, extinct some 15,000,000 years. The Institute of Evolutional Morphology and Paleozoology is sending an expedition to explore the deposits. The scientists will remain in the field from May to August.

SOME DESIRABLE CHARACTERISTICS IN CHEMISTRY DEMONSTRATION EXPERIMENTS

By Ralph E. Dunbar

Dakota Wesleyan University, Mitchell, South Dakota

At the May, 1928 meeting of the Eastern Association of Physics Teachers, Duff[1] enumerated certain desirable characteristics for demonstration experiments in physics. These criteria seemed equally applicable to the field of chemistry and have been made the nucleus of the following suggestions for chemistry as well. The list has been extended, modified and examples given from this additional field.

1. Apparatus Should Be on a Large Scale

Use small beakers or similar containers instead of test-tubes for the usual precipitation experiments. Use empty one and five pound salt bottles instead of the customary four ounce gas bottles for tests involving harmless gases. Use equipment large enough to be seen from the farthest corner of the room.

2. Apparatus Should Be as Simple as Possible

Demonstrate the variations in the vapor pressure of different liquids by introducing a small amount of each liquid into the space above the mercury in several simple barometers. The oxidation of ammonia gas can be shown by suspending a heated coil of platinum wire in the mouth of a small flask containing slightly heated ammonium hydroxide.

3. The Preparations and Experiments Should Be Carefully Arranged

The equipment should be placed in order on the lecture table so that the demonstrator can proceed logically from one demonstration to the next. The apparatus should be placed well forward on the desk, facing outward toward the students who are to observe the procedure and results.

4. Experiments Should Stimulate Further Thought

Magnesium ribbon burns in an atmosphere of carbon dioxide while a candle does not. Why? Colloidal graphite in water,

[1] Duff, A. W., "Desirable Qualities in Demonstration Experiments," School Science & Mathematics, 28, 857 (Nov., 1928).

treated with a solution of sodium chloride, may be separated by filtration while a like dispersion, without the salt treatment, can not be similarly separated. Why?

5. Positive Effects Are More Effective Than Negative

An ammonia fountain will emphasize the great solubility of this gas in water as contrasted to many other gases. Gaseous carbon dioxide, poured into a large beaker counterpoised on a good trip scale, will demonstrate the relatively high density of this gas.

6. A Slight Dramatic Element Is Sometimes Useful

Spontaneous combustion can be demonstrated by the use of pyrophoric lead or iron.[2] Hydrogen soap bubbles will emphasize the low density of this gas.

7. An Element of the Unexpected Is Sometimes Effective

Glowing charcoal will continue to burn under the surface of freshly prepared, concentrated nitric acid. The iodine clock experiment[3] shows the principle of reaction velocity.

8. Experiments Should Illustrate Principles of Some Importance

The preparation of volatile acids by the action of sulfuric acid on sodium chloride is preferable to the use of sodium iodide. Concentrated and dilute acetic acid may be used in conductivity experiments.

9. The Speed of Action Should Be Suitable

Quantitative experiments must be carefully planned and used sparingly. Necessary weighings, in so far as possible, should be completed in advance. Metallic sodium, magnesium and aluminum may be used to demonstrate equivalent weights.

10. Experiments Should Be as Nearly Infallible as Possible

Difficult or doubtful experiments should be rehearsed in advance and all variables carefully controlled to guarantee

[2] Walton, James H., "Lecture demonstrations in general chemistry," *Journal of Chemical Education*, 8, 303–6 (Feb., 1931).

[3] Deming, Horace G., *General Chemistry*, 3rd Ed., John Wiley & Sons, Inc., New York City, 1930, p. 284.

success. It is practically impossible to obtain a sample of ferrous sulfide by the direct combination of iron and sulfur that is not magnetic, due to excess or uncombined iron. Iron wire will burn readily in oxygen if a small amount of sulfur is attached to the end of the wire before the initial heating, to start the reaction.

11. The Demonstration Should be a Model for the Pupils in Clearness, Vividness, and Good Form in Presentation

Good technic on the part of the demonstrator will stimulate better laboratory work for the pupils. The outline for discussion should be carefully planned and well in mind. Conclusions should be logically deduced and accurately and clearly stated.

SATURDAY MORNING NATURE QUESTS IN DOWNTOWN INDIANAPOLIS*

By William G. Vinal

National Recreation Association

You are about to be sent on a nature quest. If in a group elect a leader. When you have agreed on the answer to each query which follows write it down. At the end of the quest study the items occurring at the end of page 5.

In case you wish to compete, the numbers in parentheses indicate the score for a correct answer.

I. A Tree Trail

Go west on New York Avenue and cross Capitol.

On this expedition look for an advertisement that has

a. Mouse	(1)
b. A Christmas Tree	(1)
c. A White Horse	(5)
d. A Shell	(1)
e. Snow	(1)
f. Star	(1)

1. What is the kind of rock used for paving Capitol? (1)

2. The trees in front of 221 are Ailanthus. They have fruit and leaf stems. What part of a motor boat does one seed resemble? Try it in the air and see if it works. (1)

* This exercise is typical of what can be done in any downtown district. The following was prepared for "Leaders" in Nature Recreation at the Indianapolis Institute.

3. Is the largest Ailanthus on the side of the house at 245 male or female? Proof?

4. The tree in front of 311 is a basswood. It has the cocoon of the Cecropia or American Silk Worm Moth. How many cocoons are there on the tree? (1)

5. At 315 it says "Dogs vaccinated for rabies." Who discovered the prevention of rabies? (1)

6. What made the stones of the "Alberta" round? (1)

7. Cross the Canal. Which way does it flow? Proof? (1)

8. Who owns the Canal? How did you find out? (1)

9. What two crops were raised at 435? (2)

10. How old are the youngest trees at 439? (1) Go to #II

II. Tree Scouting

Go west on New York Avenue to Military Park. Take diagonal path across park to the Rockery.

11. The first tree on the left that looks as though it had been whitewashed in the top is a buttonwood, sycamore, or plane tree—take your pick. What is the shape of the fruit? (1)

12. The first large tree at right of path is a linden. Stand "unter den linden" and find two evidences that it has been hit by lightning. What are they? (2)

13. What kind of fruit does it have? Describe well enough, or collect a fruit, to prove that you saw it. (1)

14. The second tree on the left has many spurs on it. It is the Ginkgo which was imported from Japan. How high are the first spurs above the ground? (1)

15. The next large tree, with thorns, is the honey locust. Draw one typical thorn as proof that you have seen the tree. (1)

16. Across the walk from the honey locust is a white ash. Look in the top of the tree to discover whether the twigs are opposite or alternate. (1)

17. The first tree on the left, beyond the lamp post is a mulberry. What insect likes the leaves? (1)

18. What is the next tree on the right of the walk? (Across from the mulberry.) (1)

19. The next large tree on the right is a white oak. It still has its leaves. What part of the tree has no leaves? Why? (2)

20. The next tree on the left has tumors and has lost its heart. If the buds are sticky it is a horsechestnut, if not, it is a buckeye. What do you decide? (1)

How far up does the hollow extend? (1)

21. What is the tree across the walk? (1)

22. At the cross walk, you will see a cherry tree on each side of the walk. What do they secrete? Why? (1)

23. Go toward the pump. The tree with long pods is the catalpa. With what instrument has it been mistreated? (1)

24. The tree to the right has "witches brooms" and is a hackberry. In what part of the tree, are most of the "witches brooms?" (1)

25. Go around the circle to the right. What are the next two trees? Proof? (2)

26. The tree at the "Y" is white ash. Prove whether male or female. (1)

27. Go to the tree, seen from this spot, that has the greatest number of "witches brooms." If you have the right tree, there is another hackberry which is the same size and not over three feet away.

28. Go to the large dead tree about 66 feet away.

29. Follow stones on left to third tree. It is a willow.

30. Go to the next nearest willow. They still have their leaves.

31. Follow path covered with oyster shells (leaving canal on right) to cement walk. Turn right on cement walk. Turn left on next cement walk. What is the first tree this walk passes that is not a sycamore? (5)

32. How many cannon balls are missing? If you still have time do the items on page 1. In this case you will read up the page.

III. Nature Shopping in Store Windows

Begin at West Market Street and Monument Circle. Go around the Circle anti-clockwise.

1. *Carters, the Haberdasher:* The base of the building is granite surmounted with sandstone. Which rock belongs to the F. F. E's (first family on earth)? How do they saw sandstone? (2)

In Carters' window, find two examples of each kind of product: *Plant* *Animal* (4)

2. *Randell, the Florist:* In the window, find a relative of the *Pansy* *Tomato* *Fern* *Daisy* (4)

3. *Maud Muller Candies:* From what plant does chocolate come? (1)

4. *Reed's Shoes:* Name 3 animals that make shoe stores possible: 1.———— 2.———— 3.———— (3)

The base stone is Verd Antique Marble. What color dominates the stone? (1)

5. *Wasson's:* What animal makes these coats possible? (1)

Are the red berries on the Hawthorne natural or artificial? (1)

What fund are they raising to help fight cancer? (1)

What animal is modeled for pepper and salt shakers? (1)

What five animals are used for design in the dishes? (5)

6. *Robinson's Eye Service:* What nerve usually is the seat of headaches? (1)

7. *Griffin Shop:* Find an example of dress goods made possible by an *Insect* *Mammal* (2)

8. *Peacock Shop:* If all plants and animals were exterminated how much would remain in this window? (1)

9. *Evard Watches and Diamonds:* From what are diamonds formed? (1)

How could you tell time by the sun? By a tree? (2)

How could you make a three-minute hour glass for boiling eggs? (1)

10. *Hudgins Carter.* Make a list of things that would appropriately appear in this window if there were no natural products from which to make them? (1)

11. (Number 11 may be done by groups or individuals.)

Group 1: See how many plant products you can list in the next quadrant. (10)

Group 2: Do the same with animal products. (10)

Group 3: Make a list of mineral products. (10)

Group 4: Make a list of things made from tropical products to be seen in the third quadrant. (10)

Group 5: Make a list of wood products seen in the store windows of the last half of the circle. (10)

IV. The Lungs of a City

Go to Southwest corner of Memorial Plaza on North Meridian Street and East New York Street.

1. The first tree, on the right (or on the left) of the diagonal path is a Norway maple. Why the guy wires? The rubber hose? The burlap? (2)

2. The young trees in the spirea shrubbery are ailanthus.

How old is the largest ailanthus? (1)

Which one has not shed all its leaf stalks? (1)

3. The first tree leaning over the walk is *basswood*. Obtain one fruit to prove you found it. What color are the buds? (2)

4. The first tree back of the seats on the right is an ornamental mulberry. Why is it so scrawny? Why is it doomed to die early? How many times has it been ringed with tar, etc.? Why? (2)

5. The next tree on the left is a *sycamore*. What is under the cup shaped base of each leaf on the tree? (Remove one to be sure.) There is evidence of bad health at the base of the trunk. What is the name for the growth? (2)

6. The next tree on the left is a mulberry. What animal would enjoy the leaves next spring? How does it differ from the first mulberry? (2)

7. The next tree is a *birch*. Crumble one of the catkins on a piece of white paper. They remind you of a great many ————. The larger things are scales and the light brown things are seeds. What would the seeds grow into? (2)

8. The next tree is a very large catalpa tree. Any fruit on it? For what animal is the house? (2)

9. Across the walk there is a *willow* which still has leaves. Find two ways in which it has been cared for. (2)

10. The smaller tree near it is a *sugar maple*. How was it injured? How far has it healed? Will it become infected before healing? How prevent its decay? (4)

11. The small tree near the catalpa is a ginkgo. It is a sacred tree in Japan where it only grows in temple gardens. Find evidence that someone was careless with a ———— which injured the tree. (1)

12. Go up the granite steps. Observe the river pebbles. How do you know that they came from a river? (1)

What kind of rocks were used to make the benches or seats? (1)

13. A catfish has feelers. How many catfish on the fountain? (1)

How many fins does the scaly carp have? (1)

Are the shell basins molds, casts, or models? (1)

14. Where are the gargoyles? Do they represent real or mythical animals? (2)

What instrument is the maiden playing? Why? (1)

15. What was the profession of Richard Johnson Depew? (1)

16. It is estimated that 300 pigeons are fed in the park every noon. Mrs. Hunter supplies on the average, two bags of grain

per week. On Sunday mornings families with children come early to feed the pigeons before going to church. The city also helps support the pigeons. Give arguments for and against them. What do you conclude? (5)

17. There are two squirrels in the park. Are they fox or gray squirrels? Find a winter nest that they made. What is the material? When they run do they place the front feet together or one ahead of the other? How many toes on the front feet? (5)

18. In the summer, during the noon hour, hundreds of people sit in this park. This land is valued in the thousands. Is the City justified in setting aside such valuable land for a park? Why? (5)

19. Find the last monument added to the park. In what way did this man get his education in the woods? (5)

20. Obtain a wing feather and a tail feather of a pigeon. How do you know the difference? (2)

V. Items for Discussion

1. In what way is this experience a lesson in English? Mark a few items E that you think contributed to a training in language work.

2. How has this been a training in Citizenship? Mark five such items with a Cit.

3. Why is it Health training? Mark health items with an H.

4. If it is Recreation mark the evidence R.

5. Has Conservation been taught? Mark any proof with Cit.

6. One of the larger concepts that teachers of science try to put across is interdependence. Has there been any thinking along this line? Where?

7. How has this been practice in cooperation, observation, and honesty? What other factors in character building do you recognize?

8. A person does not need knowledge of science to follow this project. How was it written to make it "fool proof?"

9. What have you learned in this hour? Mark five items of knowledge which are new to you with a K.

10. Does this experience justify itself as compared with an hour in the classroom? Give arguments for your conclusion.

A teacher may be tremendously enthusiastic without producing anything but noise.—*David Eugene Smith.*

COÖPERATIVE CLASS WORK IN NINTH GRADE ALGEBRA

By Johanna Geil

Solomon Juneau High School, Milwaukee, Wisconsin

Coöperative class work in ninth grade algebra is designed to make high school freshmen serious, and at the same time, happy in their work. Before discussing the teaching technique, the method employed in all classes at the school will be discussed. In general, it is felt that the greatest development of the pupils takes place when there is an abundance of discussion between the pupils themselves. The technique employed is a modification of the socialized recitation; it is called Coöperative Class Work. It is designed to increase the amount of coöperation between the pupils and to train them in courtesy; it is found to be a time saver, a thought provoker, and a means of developing and holding interest. Pupils indicate that they wish to ask or answer questions by standing at their seats. There is an abundance of discussion from the floor, pupils calling upon one another. The teachers participate only when necessary. The aim is to secure full participation of all pupils in the class, to keep them alert to the content of the discussion, to have each pupil feel that he must be responsible for his own learning, rather than to feel that he is merely trying to please the teacher, and to have the pupils learn not only how to work a problem, but why to work it in some particular way.

In the algebra classes, the period is usually devoted to several of the following types of activity: (a) Supplementary practice work, including the checking of papers and assigning of the next lesson, (b) maintenance drill, (c) blackboard drill, and, (d) problem analysis and solution, or presentation of new subject matter.

The period devoted to the "supplementary practice assignment" is related to the outside-of-class study of the pupils. In many schools much of a pupil's grade depends upon this daily study work. This often leads to copying from the paper of another pupil, or to having parents or others do the work. "Take the next ten examples" arouses very little interest on the part of the pupils. They often approach their study work with a feeling of inability to do it, and hence with an unfavorable mind-set toward it.

Our supplementary practice assignment never takes up en-

tirely new material. It consists of review practice work, including a variety of examples. No type of example is assigned until pupils have learned how to do it in class. When the assignment is made, the pupils have their texts open, difficulties are pointed out by the teacher, pupils are free to ask questions, and the pupils discuss and explain difficulties, so that the class leaves the room, feeling prepared to do the assignment.

When the study assignment is checked over in class, the answers for the examples are written upon the board and each child checks his own results. If errors occur, pupils are expected to encircle them, correcting them if time permits, or making note that the source of error cannot be determined. These papers are collected. The teacher can glance over them rapidly, because she needs to look only at those examples which have been marked incorrect. This procedure does not lead to dishonesty, since the pupils understand that no grade is given for this outside-of-class study work. They understand that the daily assignment is definitely practice work, designed to help them master their subject. If, despite previous discussion, a pupil cannot secure correct results, he may come to the teacher for special help, or bring up a difficulty in class where the pupils help him overcome it. Pupils who are found to have incomplete work often are given special invitation to come to the conference for special help. Common errors appearing in the work of many pupils are noted for discussion in the period devoted to blackboard drill.

In the time devoted to "maintenance drill," an example is written upon the board and pupils are given an opportunity to ask questions about its solution before attempting to solve it. The questions are answered by members of the class. After all the questions have been answered, the example is changed somewhat, in order to eliminate the possibility that some will be inattentive and attempt to work the first one given as soon as it is placed on the board. After the papers are collected, the example is worked at the board. This enables all of the class to see the correct solution and gives further help to any who may need it.

At the time devoted to "blackboard drill," there is the greatest departure from regular classroom procedure. The class is divided into three sections which take turns at the board. Definite places are assigned. Pupils understand that they are at the board to learn; copying from a neighbor nets them nothing.

Pupils in the seats constitute the teaching staff; they scan the board as the classmates there work; each is assigned to watch a particular worker, but may watch others if that worker does not need assistance. A pupil who detects an error stands, addresses the one who made it, and then proceeds to question him, leading him, if possible, to correct his own mistake. It may happen that several dialogues are taking place at the same time. This is economical use of the class time. If an error appears to be general, the teacher may direct the attention of the entire class to it. It is understood that there will be a high degree of courtesy and helpfulness displayed in the dialogues between two pupils.

The objectives of this blackboard drill are to relate new work to old, to eliminate errors which the teacher has observed in the supplementary practice assignment, and to recall subject matter which has been taught previously. The material selected each day is determined by what is to take place in the last part of the class period. Thus, the presentation of long division is preceded by blackboard drill on short division and subtraction; the teaching of multiplication of two polynomials is preceded by drill in the multiplication of two monomials. There is drill in previously learned processes for purpose of review and maintenance. This work, carried on before the watchful eyes of alert pupils who are ready and eager to help a classmate who may be headed in the wrong direction is exceedingly worthwhile.

The time devoted to "problem analysis and solution," or to the "presentation of new material" is employed as follows. If there is an analysis of a word problem, one pupil tells the facts given and the facts to be found, while another writes these facts upon the board. In the meantime, questions and corrections from others in the class are in order. When new material is to be presented, recall that there is, during the period of blackboard drill, review of the necessary preparatory material.

The four types of class activity are not present each day, nor do they always occur in the same order. Sometimes supplementary practice work takes most of the period; sometimes blackboard drill precedes assignment of practice work; sometimes a question asked by a pupil serves as motivation for review work, which leads to use of the entire period for blackboard drill.

There is scarcely a day in which every pupil does not participate in some one or more of the types of class work. When there

is blackboard drill, at least two of the three sections work at the board during the period; when there is maintenance drill, each pupil works at his desk; when there is discussion, more than half of the pupils are generally on their feet, ready to take part; if a pupil does not understand an explanation, he rises and says so, being just as ready to say "I do not understand" as he is to answer correctly when he does understand. The procedure does encourage spontaneous contribution by the pupils. If a reciting pupil makes an error, others at once are prepared to challenge the statements. The reciting pupil calls upon one of the challengers, who responds not by telling what is wrong, but by asking questions which enable the first pupil to find the error. It does develop a sense of responsibility both for learning and for helping others to learn. The pupils expect to take part in class work, and they complain when they are not called upon often enough. They secure deeper insight than is often present, because a child must himself understand a problem thoroughly in order to ask questions which will help another to understand it. The procedure adds to the pupils' interest in their subject. Evidence of this has been secured by canvass of the pupils in the class. Altogether, it is felt that this technique accomplishes what it is designed to do.

MOON TIDES IN EARTH'S UPPER ATMOSPHERE AFFECT RADIO RECEPTION

Owners of the new high-powered radio receivers may get their thrills from "picking up" distant stations throughout the United States and foreign lands, but scientists use these distance signals to study the tides created by the moon in the ionized layers miles above the earth which make such transmission possible.

Dr. Harlan T. Stetson, of Harvard, presented new facts about the moon tides in the radio reflecting layers before the joint meeting of the Institute of Radio Engineers and International Scientific Radio Union.

Dr. Stetson studied the changing intensity of radio signals between KFI Los Angeles and WBBM Chicago and Delaware, Ohio, as the moon moved across the sky at night.

Correlating his findings with observations made at Harvard University by Prof. H. R. Mimno, Dr. Stetson concludes:

"These results may be interpreted as indicating that when the moon is opposite the sun there is a tendency for an increase in the ionic density on the night half of the earth's atmosphere thus favoring increased number of reflections (better reception) from the E layer."

The E layer refers to one of the several zones of ionized particles which reflect radio waves.

THE STATUS OF SCIENCE IN COLLEGES AND UNIVERSITIES

By John F. Shea
Redondo Beach, California

The investigation was carried on for the purpose of determining the extent to which science is emphasized in institutions of higher learning.

Special attention was paid to the amount of emphasis placed upon the practical sciences, in comparison to that placed upon the specialized sciences.

For various reasons, the field of study was limited to the consideration of science in four major types of institutions,—(1) coeducational liberal arts colleges, (2) teachers colleges, (3) universities (colleges of arts and sciences, only), and (4) liberal arts colleges for women.

The study was based upon data obtained from the current catalogs of 234 colleges and universities located in forty-five states and the District of Columbia. Since the catalog course titles were remarkably varied and misleading as to the exact content, courses were grouped according to the catalog descriptions of the course subject-matter. In all, forty different groups, or types of science courses, were used to tabulate the hundreds of science courses.

The accompanying table indicates the ranking of the sciences on the basis of average semester hours in all the institutions. It will be noted that of the eight practical sciences (bacteriology, nature study, general science, exterior decorating, applied chemistry, family health, therapy and eugenics), only one, bacteriology, ranked relatively high. In totalling the average semester hours of these eight practical sciences, it was found that they comprised only 9.8% of the total average semester hours of all the sciences. The physical sciences totalled 55% and the biological sciences totalled 34%. In the teachers colleges, 13% of the sciences were of a practical nature.

The ratio of emphasis placed upon biological and physical sciences (including the practical sciences) in all colleges and universities was approximately three to four.

Thirty-five per cent of the institutions stated science entrance requirements. On the basis of 234 colleges and universities, there were .37 units of science required by each institution, while the average for each institution where any was required was 1.08 units.

Fifty-nine per cent of the institutions offered some kind of pre-professional curricula. The number offering pre-medical,

AVERAGE SEMESTER HOURS IN TWO HUNDRED AND THIRTY-FOUR COLLEGES AND UNIVERSITIES

Subjects	*In 43 coed. colleges*	*In 69 teachers colleges*	*In 57 universities*	*In 65 women's colleges*	*Ave. sem. hrs. in 234 colleges and universities*
Adv. Physics	15.35	11.59	36.31	9.81	18.26
Botany	10.73	10.10	36.98	11.61	17.35
Geology	10.60	6.03	36.03	5.37	14.51
Gen. Physics	13.48	10.71	20.79	12.73	14.43
Gen. Chem.	13.53	11.20	20.45	10.40	13.90
Organic Chem.	11.23	7.98	21.35	9.80	12.59
Bacteriology	6.42	5.40	18.60	8.04	9.61
Zoology	4.79	4.62	15.61	4.50	8.38
Quant. Chem.	7.42	5.07	13.40	5.90	7.95
Physiolog. Chem.	2.76	5.27	10.19	7.87	6.52
Physical Chem.	4.30	2.62	13.36	3.84	6.03
Physiology	4.09	4.10	10.17	5.01	5.84
Agricult. Subs.	.69	11.82	2.16	...	4.89
Biology	5.23	4.92	3.56	4.93	4.66
Qual. Chem.	4.35	3.34	6.20	4.53	4.61
Vertebrate Zool.	4.83	2.84	6.70	3.55	4.48
Astronomy	4.53	1.42	5.56	5.26	4.19
Chemical Eng.	.35	...	7.40	...	3.88
Histology	3.25	1.01	6.63	3.52	3.60
Chemical Research	1.09	...	4.19	...	3.14
Entomology	1.55	1.56	8.37	.73	3.06
Embryology	3.30	1.15	4.95	2.81	3.05
Genetics	2.51	2.24	3.84	2.53	2.78
Anatomy	1.34	2.17	3.95	2.64	2.52
Invertebrate Zool.	2.14	1.28	2.63	1.732	1.95
Nature Study	.60	3.63	1.05	1.738	1.75
General Science	1.45	3.49	1.40	.46	1.70
Exterior Dec.	.27	.75	1.19	1.57	.97
Applied Chem.	1.04	1.17	.71	.60	.88
Evolution	.58	.34	1.58	.92	.85
Family Health	.56	1.18	.63	.74	.78
Science Teach.	.69	1.63	.26	.52	.77
Therapy	.23	1.21	.70	.86	.75
Biology Teach.	.37	1.05	.56	.66	.66
Ornithology	.41	.68	.87	.60	.64
Chemistry Teach.	.51	.50	.37	.58	.49
Colloidal Chem.	.23	.07	1.21	.30	.45
Eugenics	.07	.79	.21	.55	.40
Physics Teach.	.35	.39	.42	.10	.31
Photography	.04	.34	.38	.43	.30

pre-nursing and pre-dental curricula were 123, 38 and 33, respectively.

Eighty-six per cent of the institutions supplying data stated the requirements for a B.A. degree. On the average, 8.6 semester hours of science were required for the degree.

Fifty-one per cent of the institutions supplying data stated the science requirements for a B.S. degree. On the average, 15.2 semester hours were required for the degree. This was 6.6 semester hours more than that required for the B.A. degree.

In teachers colleges, 10.02 average semester hours were required for the B.S. in Ed. degree.

The requirements for a major in science were specified by 79% of the institutions considered. An average of 23.8 semester hours was required by each.

Sixty-one per cent of the institutions studied definitely stated the requirements for a minor in science. An average of 15.5 semester hours were required by each. This was 8.3 semester hours less than those required for a major.

In summarizing the data of the entire thesis, the following facts were evident:

1. That forty different sciences were offered in colleges and universities, ranging in importance from advanced physics, with an average of 18.26 semester hours per institution, down to photography, with an average of .30 semester hours per institution.
2. That the average semester hours per institution indicated that the specialized sciences predominate, while comparatively little emphasis was given to the practical sciences.
3. That the average semester hours of the biological sciences were approximately three-fourths what the average semester hours in physical sciences were.
4. That on the basis of total average semester hours, the ranking of the science groups were: (1) physical sciences, (2) biological sciences, (3) applied sciences, and (4) miscellaneous sciences. That approximately ten per cent of the total science offerings were of a practical nature.
5. That the 234 institutions studied required an average of .37 units of science for entrance, while the average in just those institutions stating a requirement was 1.08 units.
6. That 58.5% of the total number of institutions considered offered some kind of pre-professional curriculum. The per cents of those offering pre-dental, pre-medical and pre-nursing, were 14.1, 52.6 and 16.2, respectively.

7. That the requirements for a B. S. degree were 6.6 semester hours more than those for a B. A. degree and average 15.2 semester hours.

8. That the requirements for a major in science were 8.3 semester hours more than those required for a minor in science and averaged 23.8 semester hours for each institution stating a requirement.

In addition to the above summary, the following conclusions were drawn as a result of the study:

1. That although there are hundreds of different titles for science courses, the subject-matter of these may be differentiated into forty fields with a minimum of overlapping. Since the content differs little under so many course titles, it is highly recommended that courses be universally entitled on the basis of content. A sub-title may indicate the special considerations or restrictions of the course.

2. That more effort should be made to have all colleges and universities employ the same terminology of credits, hours of study and semester divisions.

3. That from the high degree of specialization in colleges and universities, it seems evident that ample opportunity is afforded students desiring to enter the fields of scientific research and discovery for a better control and adaptation of our environment.

4. That from the per cent of practical sciences offered, it seems that colleges and universities have not as yet recognized the consumer values of science.

EXPLORERS TO USE TANK

Peaceful science, rather than destructive war, is the end in view for a tank now being constructed by a Swiss engineer, Herr Bachmann, at Horgen, Switzerland. It is intended to carry a party of German, Swiss and South American explorers into the "green hell" of the Amazonian jungle.

The turret on top of the tank will carry, not a machine gun, but a sound-recording motion picture camera. Caterpillar treads are expected to make going possible through thick jungle and marshy ground. The tank is an amphibian, with pontoons for river navigation.

Within the steel shell, the exploring party expects to be safe alike against the arrows and bullets of implacably hostile savages, the bites of poisonous snakes and disease-carrying insects, and the possible onslaughts of wild animals.

SCIENCE SHOWS OR SCIENCE CLASSES?

By Louis R. Welch

Dorchester High School For Boys, Dorchester, Massachusetts
Lecturer on Methods of Science Teaching
Boston College Summer School

"Have you ever studied General Science before?" I asked a pupil in a Grade IX Science class last September.

"Sure," was the prompt reply.

"What did you study about?"

"Well, our teacher made two balloons go apart."

Upon further questioning it appeared that a demonstration of static electricity had made a lasting impression on this chap's memory. But what kind of an impression? He remembered that he had seen his teacher rub a red balloon and a green balloon with cat's fur and that after this treatment they "went apart." But as to the underlying principles of this phenomenon and its applications to everyday life he remembered nothing.

This example illustrates a common mistake in the teaching of General Science. We entertain the children, just as a magician entertains his audience, with explosions, color changes, and ringing bells. We fill the subject with beta units and make it the easiest and most enjoyable subject in the curriculum. This would be a laudable purpose for a vaudeville show, but hardly for a standard Junior High School subject.

General Science is a subject that can be easily motivated. It is a well-known principle of psychology that the more senses of a child you can stimulate the more lasting will be the impression on his mind. In the preparation of some of the more striking demonstrations of General Science this principle has been given much consideration.

The teacher however should use great care in selecting experiments of this type. They should be suited to the mentality of the class and as closely related to the every day life of the pupil as possible. If this is not done, the teacher, not the class, profits most from such a lesson. The teacher acquires a certain magician's technique and, if he is not careful, a self satisfied idea that he is putting his subject across with most excellent results; whereas the pupils, being normal individuals, are interested in hearing noises and seeing color changes but seldom care to learn the principles behind these phenomena.

Every new teacher must struggle to get attention and disci-

pline from his classes. Soon he finds that discipline follows attention. Hence, in his early teaching experience he learns to use those experiments which will best hold the attention of his class. However, an experiment which is most interesting to the average boy is not one which causes him to do a great deal of thinking for himself. These Science Shows that entertain the class "go over big." The class enjoys them and isn't backward about saying so. Struggling to get his class under control, the new teacher finds that such experiments serve his purpose well and, following the line of least resistance, he spends his afternoons and evenings getting apparatus together for the next show.

Science supervisors are also responsible in some measure for this state of affairs. On visiting a Science class they expect to see a demonstration by the teacher that will hold the attention of every pupil and he gives them such a demonstration; bells ring, lamps light, or explosions occur. The pupils may be actually breathless.

"A wonderful lesson," says the supervisor.

"And a wonderful teacher," thinks the instructor to himself. The next day, however, he is apt to find that hardly a pupil can explain what the preceding "wonderful" lesson was all about.

Such experiences are both discouraging and thought provoking. Surely in a lesson which an expert considered perfect some of the points which were demonstrated should have remained in the pupils' mind overnight. Too frequently, however, the results from such a lesson are disappointing, perfect motivation, perfect attention, but few lasting impressions. Apparently, almost any Science teacher, given the proper apparatus and average ability, can entertain a class and hold their interest. But to teach a class while thus entertaining them is a much more difficult and seldom accomplished task.

This does not mean that spectacular demonstrations should be abolished in General Science. They are its most valuable and essential assets for motivation. But they should be kept in their places as motivating agents. They should not make up the content of the entire Science period or course. Demonstrations whose explanations are beyond the grasp of Junior High School pupils, should not be shown simply to entertain the pupils. Such demonstrations may, however, be properly shown in the Science Club where a select group of pupils should profit by

seeing them. The Science teacher who is really interested in teaching more than in entertaining should strive to make his classes realize that Science today is a group of principles, interesting it is true, but to be learned and mastered only by honest effort on the part of the pupil himself.

NOTE ON CURVILINEAR ASYMPTOTES

By Lester Dawson
Wichita, Kansas

Consider the curve whose equation is

$$y=\frac{F(x)}{f(x)} \tag{1}$$

where $F(x)$ and $f(x)$ are rational, integral algebraic functions of x and where the degree of $F(x)$ exceeds the degree of $f(x)$ by an integer $n \geqq 0$. We have by long division

$$y=a_0x^n+a_1x^{n-1}+\cdots+a_{n-1}x+a_n+\frac{r(x)}{f(x)} \tag{2}$$

where $r(x)$ is a rational, integral algebraic function of at least one degree lower than $f(x)$. Under the preceding conditions, the

$$\lim_{x\to\infty}\frac{r(x)}{f(x)}=0 \tag{3}$$

so that the curve (1) approaches more nearly the curve

$$y=a_0x^n+a_1x^{n-1}+\cdots+a_{n-1}x+a_n \tag{4}$$

as x increases indefinitely, in other words the curves (1) and (4) become more nearly congruent curves. The curve (4) may be termed a *curvilinear asymptote* of the given curve (1).

Two important special cases yield ordinary linear asymptotes.

Case I. If $F(x)$ and $f(x)$ are of the same degree, that is $n=0$, we obtain by division

$$y=a_0+\frac{r(x)}{f(x)}$$

whence by (3), $y=a_0$ is the horizontal linear asymptote.

Case II. If the degree of $F(x)$ exceeds that of $f(x)$ by one, that is $n=1$, then equation (4) becomes

$$y=a_0x+a_1$$

which is an oblique linear asymptote.

It is clear that corresponding statements hold for the curve whose equation is

$$x=\frac{F(y)}{f(y)} \tag{5}$$

where $F(y)$ and $f(y)$ are subjected to the same conditions as are $F(x)$ and $f(x)$ in the preceding discussion.

EXERCISES

1. Show that $y=x$ is an asymptote of the curve

$$y=\frac{x^2+5x+1}{x+5}.$$

2. The curve $y=\dfrac{x^4+x^2-3}{x^2+1}$ has the parabolic asymptote $y=x^2$.

3. It is instructive to note that $y=\dfrac{x\sin x+1}{x}$ has the curvilinear asymptote $y=\sin x$, since by division $y=\sin x+\dfrac{1}{x}$ and since $\lim_{x\to\infty} 1/x=0$.

Hence in certain cases, the curve (1) may approach a curvilinear asymptote even when the restriction that $F(x)$ and $f(x)$ both be algebraic functions is removed.

STANFORD UNIVERSITY TO HOLD SUMMER CONFERENCE ON CURRICULUM AND GUIDANCE

Stanford University will conduct a summer Conference on Curriculum and Guidance during the week of July 6 through 10 on the Stanford campus. Among the nationally known educational leaders who will participate in the conference are John Studebaker, United States Commissioner of Education; George S. Counts of Teachers College, Columbia University and Research Director of the American Historical Association's Commission on the Social Studies; H. L. Caswell of George Peabody College, Nashville, Tennessee and Chief State Curriculum Consultant to the states of Virginia, Alabama, Mississippi, Georgia, Florida, and Arkansas; C. L. Cushman, Director of Curriculum and Research of the Public Schools of Denver; Worth McClure, Superintendent of Schools of Seattle; Peter Sandiford, psychologist from Toronto University; C. A. Howard, Vierling Kersey, and H. E. Hendrix, state superintendents of education of Oregon, California, and Arizona respectively; Frederick Redefer, Executive Secretary of the Progressive Education Association; R. D. Russell, Curriculum Consultant to the State of Idaho; and Emmett Brown, Professor of Science Education at Teachers College, Columbia University and Lincoln School of Teachers College. These and other visiting contributors will assist the staff of Stanford University and the talent available in the public schools and colleges on the Pacific Coast.

This conference is planned to serve classroom teachers on all levels of the school system, curriculum workers, guidance workers, supervisors, administrators, research workers and the lay public.

A stop-over at Palo Alto may be included in a round-trip rail ticket at little or no extra cost for those attending the summer meeting of the National Education Association at Portland, Oregon. Details concerning the total program and the arrangements of the Stanford conference may be obtained by addressing an inquiry to Dean Grayson N. Kefauver of the School of Education, Stanford University, California.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred Thirty-second Meeting

THE WINSOR SCHOOL

Boston, Mass.

Saturday, March 21, 1936

PROGRAM

9:45 Meeting of the Executive Committee.

10:00 Business Meeting.

Report of the Committee on College Entrance Requirements. Mr. Burton L. Cushing, East Boston High School, Chairman.

Report of the Committee on Magazine Literature and New Books. Mr. Carl W. Staples, Chelsea High School, Chairman.

Report of the Committee on Current Events. Mr. Winthrop S. Drury, Middlesex School, Chairman.

10:30 Address of Welcome. Miss Katharine Lord, Director, The Winsor School.

10:45 Display and Demonstration of New Apparatus. Mr. Joseph M. Arthur, St. Mark's School, Chairman.

11:15 Discussion of Results of Mathematics Test given to Science Pupils. Mr. Charles B. Harrington, Newton High School.

11:30 "The Old and New in Our Elementary Physics Course." Prof. N. Henry Black, Harvard University.

12:30 Luncheon at The Winsor School.

1:30 "Visual Education and the Use of Teaching Aids, with Particular Reference to Physics." Mr. Abraham Krasker, Director Department of Visual Aids, Quincy Public Schools, and Instructor in Visual Education, Boston University.

The Winsor School is located in Boston on Pilgrim Road a short distance from the Deaconess Hospital. Pilgrim Road parallels a part of Brookline Avenue and intersects the Riverway at each end. Buses of the Boston Elevated Railway running from Kenmore Station to Cypress Street pass along Brookline Avenue.

Mr. Krasker is well known as a pioneer and an authority in the field of visual education, and his address should be of value to all Physics teachers who desire to keep abreast of developments in this important branch of educational endeavor. Motion pictures will be used by Mr. Krasker to illustrate his talk.

Prof. Black's address will deal with vital matters in connection with present day Physics teaching in secondary schools. Members of the E.A.P.T. will know that this talk is certain to be of interest and of practical value.

Members are asked to give their pupils the mathematics test distributed by Mr. Charles B. Harrington at the Newton meeting and to send him the results in time to be summed up for this meeting. He may be addressed at Newton High School, Newtonville, Mass.

The price of the luncheon will be fifty cents and all requests for reservations must be in the mails not later than Monday, March sixteenth, ad-

dressed to Miss Anna E. Holman, The Winsor School, Pilgrim Road, Boston, Mass.

Members are urged not to miss any part of this interesting meeting and to extend to all who might be interested a cordial invitation to join us in enjoying the hospitality of this fine private school.

OFFICERS OF EASTERN ASSOCIATION OF PHYSICS TEACHERS

President, LAWRENCE A. HOWARD, High School, East Boston, Mass.
Vice-President, ROBERT W. PERRY, High School, Malden, Mass.
Secretary, WILLIAM W. OBEAR, High School, Somerville, Mass.
Treasurer, PRESTON W. SMITH, 208 Harvard St., Dorchester, Mass.

Mr. Arthur L. Lawrence of the Newton Country Day School was elected an active member.

Mr. John A. Fisher of the East Boston High School was elected an associate member.

Mr. Cushing reported for the Committee on College Entrance requirements. The following recommendations presented by the committee were adopted by the Association.

1. That the E.A.P.T. approves the first and second levels proposed by the Commission on Examinations in Science, but only as long as the first level is maintained.
2. That the E.A.P.T. requests that no further action be taken on the third level plan until sample examinations have been published for approval or disapproval by the various science organizations.
3. That the attention of the College Board be called to the fact that although one third of all candidates each year come from the public schools, there is no public school science teacher on the Commission on Examinations in Science.
4. That the E.A.P.T. requests a revision of the Syllabus requirements in Physics.

Mr. LeSourd spoke of the American Science Teachers' Association. For two years its organization committee has been seeking to learn the sentiment of officers and influential members of existing associations of science teachers as to the advisability of establishing a nation-wide organization whose membership should include all members of the various associations together with others who may desire membership. The response has been strongly in favor of the plan and many suggestions have been made as to possible functions of such an organization. At the St. Louis meeting last January a constitution was submitted for adoption but it was decided to delay such action for one year and to invite a number of "key men" widely scattered geographically to become charter members. These are to study the constitution, the proposed activities and the relation of local associations to the new one. From this group it is hoped that associations will select well-informed delegates to attend the meeting to be held next January at Atlantic City.

The Secretary of the organization is Mr. E. S. Obourn, 53 Jefferson Road, Webster Groves, Missouri.

The Association voted that we express our interest in supporting this organization.

The Industrial Trips Committee, Charles S. Lewis, Chairman, announced a field trip for Saturday, April 11, to the Simplex Wire and Cable Company in Cambridge.

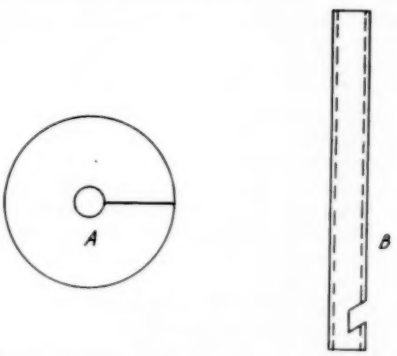
It was voted to extend the thanks of the Association to the Winsor School for its hospitality in entertaining us so pleasantly at our 132nd meeting.

REPORT OF COMMITTEE ON NEW APPARATUS

MR. J. M. ARTHUR, *St. Mark's School, Southboro, Chairman*

Mr. H. D. Hatch of the English High School, Boston, Mass., explained two new pieces of apparatus as follows:

While trying various materials in the new Hatch type expansion apparatus the idea of trying rubber tubing was suggested by experiments I had heard of at Exeter. The effect proved so large that no magnification is necessary. The problem develops into a question of how to hold a rubber tube tightly without collapsing it and the following is a simple solution.



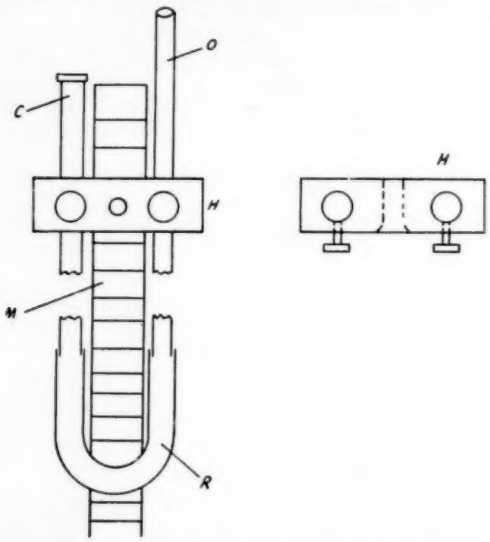
Take a solid rubber stopper (*A*) and bore a 6 mm. hole in it or one just smaller than the rubber tubing you expect to use. I use ordinary 7 mm. red rubber tubing. Then cut the stopper along a radius so you can open it and slip the tubing into the hole. Now hold the stopper in a ring stand clamp and when you tighten the jaws of the clamp the stopper is compressed enough to hold the tubing tightly.

At the other end of the tube I insert a quarter inch metal tube (*B*) with a slot. In the slot you can catch a string and a weight. Use a ring stand clamped to the edge of the table. A piece of rubber tubing four feet long will reach from the boiler to the stopper at the top of the ring stand, pass it through and let it hang over the edge of the table several feet. I suggest you try different weights on the free end. And you will probably find as I do that with a kilogram of tension the steam expands the tubing less than it changes the elasticity and the tubing *shrinks*.

Here is an improved form of Boyle's law apparatus using mercury to seal in the air and cause pressure. A closed glass tube (*C*) and an open one (*O*) are connected by a rubber tube (*R*) and held by two metal pieces (*H*) screwed to a meter stick (*M*). The meter stick may be held by a ring stand or fastened permanently to a wall. Tube *C* is an ordinary glass tube about 50 cm. long; hold one end in a burner until it is sealed and at once press it gently against a piece of old wood. The end will be flattened and the end of the air chamber will be straight instead of rounded. This is quite an advantage as students often measure to the end of an air column regardless of its shape. *O* is an ordinary open glass tube 50 cm. or longer depending on the range of pressures you wish. *H* is conveniently made from half inch square metal stock. The thumb screws to hold the glass tubes are 8–32 as

that is a standard thread and easy to replace. Filling the apparatus with mercury part way up O and C is a nuisance but only has to be done once.

In use the student moves the closed end of C just to the zero end of the meter stick, then raises or lowers O as far as possible. Measurements of the pressure, barometer, and volume are conventional. The advantages of this form are four: it is accurate; a poor student gets PV products within one per cent, the average student does twice as well. It is quick; it is ready for use all the time, the measurements for six trials can be made in five



minutes and the experiment finished in one period. It is inexpensive; if the laboratory contains a meter stick, mercury, rubber and glass tubing, only holder (H) and screws need be made. Any teacher who does not have the facilities for metal work may write me and I shall be glad to recommend my machinist. The last and distinctive feature is that any trial can be repeated. It is often hard for the teacher to find why a student's results are inconsistent but with this form you can reset the apparatus to any P or V and check the other.

Dr. Martin Grabau of the Polaroid Corporation gave an interesting talk on Polaroid. He explained some parts of the method of manufacture and demonstrated its properties by means of projection lantern and moving pictures.

The report of Mr. Fletcher's Gay-Lussac Law apparatus which was given at the December meeting appears on page 407 of the April number of SCHOOL SCIENCE AND MATHEMATICS.

Miss Katherine Lord, Director of the Winsor School, welcomed us most cordially saying in part:

I wish only to say welcome to you and not to do anything so formal or so presumptuous as to address you. I feel interested and honored that you are here. I am heartily glad you are meeting. The Private School

Association, The Head Mistresses Association, the History Reference Council have met in our halls but never a scientific group or a group made up of public and private schools meeting together. The meetings at this time have special value for the Commonwealth.

Some of you may have had the experience that I have had these last three weeks, of going to the hearing on the repeal of the Teachers' Oath before the Joint Legislative Committee on Education; but many of you may have been held in your classes or in that your subject was not history or economics have felt so far from the firing-line that you did not feel moved to attend. The hearings were stirring occasions, more stirring even than the papers made them. Whatever we may have thought of the harmlessness of the oath, those meetings served to show that the dangers to public and private schools from more extended legislative control were imminent. They showed, to my thinking, that the legislature had the intention of increasing their power and they showed that power would be in the hands of people hostile to the spirit of true education. Two sentences were burned into my mind: "Yes, that (referring to I do not know what) concerns public school education, but we will 'get' the private schools next," and, "Who is to determine what is the truth, the teachers or the will of the people as declared through their representatives in the legislature." The implication was clearly that the 'will' of the people should determine the truth. Unquestionable danger here to an essential purpose of education. Such small groups as yours, cross-sections of public and private schools, can constitute themselves committees of safety for exchange of news, opinion, and plans for action; government control reaches the public school first, but private schools will join with organizations which have their value in registering opinion.

Scientists, because of the nature of their work, have perhaps more clearly formulated in their own minds conception of truth and a way to pursue it, and have a concern in more directly teaching that attitude to their pupils than most other groups. It is the scientific attitude towards truth which so needs to be conveyed to the rank and file of citizens if we are to have our education unhampered. Scientists in the teaching of young people can do more than any other group possibly, to convey this attitude.

The hearing, besides showing clearly the temper of the legislators, showed a bad rift between the mind of the educators who spoke and the minds of the members of the committee. The language in which arguments were framed rose from a kind of thinking too far removed to be anything but antagonistic to the listening legislators. Scientists, with their continual shuttling between the intellectual world and daily concrete living, between electricity and electric lights, can speak of the concepts of an intellectual world so that the plain man can understand that a practical person is speaking even if he cannot always understand in detail what that practical person is saying.

You are doubly welcome—as scientists, as public and private school people. I hope you will use the school for purposes of education and enjoyment and will want to come again.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE AND NEW BOOKS

MR. CARL W. STAPLES, *Chairman, Chelsea High School*
MR. KENNETH L. GODING, *Attleboro High School*
MR. THOMAS C. BAILEY, *Hartford Public High School*

NEW BOOKS

Telephotography, 4th Ed. by Frederick Lan-Davis. Pitman, publishers, 1935.

A History of Science, Technology, and Philosophy in the Sixteenth and Seventeenth Centuries, by A. Wolf. Macmillan Co., publishers, $7.00.

Outposts of Science. A Journey to the Workshops of Our Leading Men of Research, by Bernard Jaffe. Simon and Schuster, publishers, $3.75.

The Next Hundred Years (The unfinished business of science) by C. C. Furnas. Peynal and Hitchcock, publishers. 434 pp. $3.00.

Transportation by Water, by E. R. Johns and others. Appleton Co., N. Y. publishers, 1935. 585 pp. $5.00. Comprehensive consideration of all aspects. Biographical references for each chapter. A basic handbook on the subject.

Count Rumford of Massachusetts, by J. A. Thompson. Farrar & Rinehart, N. Y. 1935. 275 pp. $3.00. A New England scientist of Revolutionary days, a pioneer in city planning, served as Chamberlain in Bavaria. Founder of the Royal Institution in London, and Rumford professorship at Harvard. Bibliography included.

Aristotle, Galileo, and the Tower of Pisa, by L. Cooper. December, 1935.

Roman Mines in Europe. December, 1935.

A Fugue in Cycles and Bels, by John Mills. The rôle electricity plays in music.

BOOK LIST

"New Pathways in Science."

"A Reading List of Books on the Applications, Implications, and Achievement of Modern Science." Compiled by the M.I.T. Library.

"Technology Review" March, 1936, p. 223.

MAGAZINE LITERATURE

Academic Freedom

"The Fight for Academic Freedom," by Hartley Gratton, *Survey Graphic*, March, 1936. P. 143.

Air Conditioning

"Air Conditioning of the United States Treasury," by Berman and Gerhardt, *Heating and Ventilating*, February, 1936. P. 25.

"Blow Hot, Blow Cold" (New Principles of air conditioning) by Ward, *Arts and Decoration*, January, 1936. P. 32–33.

"You and Ions," by H. T. Stetson, *Reader's Digest*, February, 1936. P. 103–104.

"What Air Conditioning Means," by M. O. Whitton, *Parents Magazine*, December, 1935. P. 30.

Alloys and Metals

"New Marvels in Metals," *Popular Mechanics*, March, 1936. P. 321.

"The Lost Art of Hardening Copper," by Prof. Norman J. Harrar, *Scientific Monthly*, February. P. 142.

"Fifty Years of Aluminum," *Popular Science Monthly*, February, 1936. P. 25.

"Preparing Metals for Microscopy," by F. F. Lucas, *Bell Laboratories Record*, December, 1935. P. 116–119.

Astrophysics

"L'Éclipse Totale de Lune du 8 janvier," *L'Illustration*, January 4, 1936. P. 27.

"The Simpler Aspects of Celestial Mechanics," by Homer A. Harvey. Foreword for a series of articles, *Popular Astronomy*, February, 1936. P. 69.

Atmosphere

"Man's Farthest Aloft" by Capt. Albert W. Stevens, with 40 illustrations, *National Geographic Magazine*, January, 1936. P. 59–94.

See also "*Scientific Monthly*," January, 1936. P. 93–98.

"Harnessing Icy Polar Gales for Power," *Popular Science*, March, 1936. P. 25.

Atomic Physics

"Energy from Matter"—Low efficiency of transmutation, by E. U. Condon, *Scientific American*, December, 1935. P. 300–301.

"Study of the Atom," *Science* Supplement #13. December 13, 1935.

"Electron Microscope for Study of the Atom," *Science* Supplement #5. January 17, 1936.

"Energy Linking Atoms in Molecules," *Science* Supplement #7. January 10, 1936.

"Why Does the Atom Stick Together?" by J. Harrington, *Scientific American*, February, 1936. P. 80–82.

Aviation

"Wings Over Four Continents," *Popular Mechanics*, December, 1935. P. 866.

"Air Lines Seek Standard Planes." Five companies form association and ask manufacturers to build planes to standard specifications *Business Week*, January 18, 1936. P. 32.

"La Décoration d'un Grand Paquebot Aérien," *L'Illustration*, January 4, 1936. P. 9.

"Sweden is Air-Minded," by Olof Kjellgren, *The American Swedish Monthly*, February, 1936. P. 16.

"All the Comforts of Home at 200 m.p.h. New Douglas Sleeper," *News Week*, December 28, 1935. P. 30.

"Flying the Bearns," *Popular Mechanics*, March, 1936. P. 402.

"Super Pilots of To-morrow," *Popular Science*, March, 1936. P. 29.

"There's Safety in Height," *Popular Mechanics*, January, 1936. P. 52–54.

"Air-plane Engines-Lubrication"; Cold weather operation, by A. Klemin, *Scientific American*, February, 1936. P. 89–90.

"Airplanes of Plastic Materials?" by A. Klemin, *Scientific American*, February, 1936. P. 105.

"New Things in Aviation," by H. Mingos, *Review of Reviews*, December, 1935. P. 32–36.

"Airships—Flying House LZ-129," *Christian Science Monitor Weekly Magazine*, December 4, 1935. P. 8.

"Conquering Hazards of the Air," by K. A. Smith, *Travel*, January, 1936. P. 44.

Biographical and Historical

"Morse Peintre de Lafayette"; "Un aspect peu connu de l'inventeur du télégraphie," *L'Illustration*, January 4, 1936. P. 18.

"Watt's Steam Engines," *English Mechanics*, December 13, 1935. P. 197.

"James Watt. Mention of bicentenary; Portrait, also picture of Watt's engine, Old Bess, and his laboratory at Heathfield," *Technology Review*, February, 1936. P. 170.

"André-Marie Ampère" by Rollo Appleyard. This year's centenary celebration, *Electrical Review*, January 24, 1936. P. 116.

"Science Review of the Year," *Science*, December 27, 1935. Supplement 6.

Biophysics

"Machines Which Imitate Life" (Lindbergh's Pump and Other Biological Models), by George W. Gray, *Harper's Magazine*, February, 1936. P. 341.

Construction

"Bridges, from Grapevine to Steel." With illustrations, *National Geographic Magazine*, March, 1936. P. 391.

"World's Greatest Dam." (Diagrams, plans, illustrations, etc.) ("To Create an Electrified Paradise"), *Popular Science Monthly*, February, 1935. P. 11.

Crystallography

"On the Structure of Solid Bodies," by E. Wigner, *Science Monthly*, January, 1936. P. 40–46.

"Primary Crystallization of Metals" (The cooling of an ingot is taken to illustrate the formation of crystals during solidification), by F. R. Hensel, *Blast Furnace and Steel Plant*, February, 1936. P. 145.

Dust Explosions

"When Dust Goes up in Smoke," by David J. Price, Ph.D., *Scientific American*, February, 1936. P. 71.

Electricity

"Flaming Rivers of the Sky," by Hugh Duncan Grant, *Travel*, March 1936. P. 24.

"High Voltage Research for Commercial Use," by Boone, *Scientific American*, February, 1936. P. 84–85.

Electroplating

"Electrocoating Sandpaper" (A method of procuring greater abrasiveness), *Electrical Review*, January 24, 1936. P. 121.

Fluorescence

"Magic Eye Reveals Hidden Mineral Treasures," *Popular Science Monthly*, March, 1936. P. 16.

Geophysics

"How Safe is a Sky-Scraper?" *Popular Mechanics*, March, 1936. P. 376.

"North America Being Pulled into the Pacific Ocean," *Science* Supplement #6, January 31, 1936.

"Earth Current Measurements," by Mary K. Corr, *Bell Laboratories Record*, December, 1935. P. 106–110. Illustrated.

Heat

"Heat Transmission Tables, Values of "U" for Masonry Walls. H. & V's Reference Data," *Heating and Ventilating*, February, 1936. Opposite P. 54.

"Mirrors Capture Sun's Heat to Smelt Ore," *Popular Science Monthly*, February, 1936. P. 18.

"Coldest Cold Produced by Great Magnet," *Popular Science*, March, 1936. P. 41.

"Approach to the Absolute Zero of Temperature," by F. Simon, *Scientific Monthly*, December. P. 530.

Hydrogen

"Hydrogen-Di-Pole Attraction and Hydrogen Bond Formation in their Relations to Solubility," by J. H. Hildebrand, *Science*, January 10, 1936. P. 21–24.

"Hydrogen Outburst on the Sun and Radio Fading," *Science* Supplement #6, January 10, 1936.

Invisible Radiations and Radioactivity

"X-Ray Studies of Crystals Vibrating Piezoelectrically," by Carl V. Bertsch, *Physical Review*, January 15, 1936. P. 128.

"Fluctuations in Cosmic Ray Ionization," by Richard L. Doan. *Physical Review*, January 15, 1936. P. 107. Also several articles on spectra.

"Protoactinium-Disappearance of a Speck Weighing One Tenth of a Gram of Pure Protoactinium," *Time*, January 27, 1936. P. 37.

"Artificial Radium; Making Other Elements Artificially Radioactive," by E. V. Condon, *Scientific American*, January 1936. P. 5–8.

"Radium on the Breakfast Table; New Atom Smashing Machine, Cyclotron," *Literary Digest*, December 28, 1935. P. 16.

Light

"Searchlights to Explore the Upper Air 20 to 25 Miles Above the Earth," *Science* Supplement #13, December 13, 1935.

Meteorology

"How to Construct an Inexpensive Rain-Gauge," *Popular Science Monthly*, April, 1936. P. 60.

Mining Physics

"Miner's Safety Lamps Design, Characteristics, and Performance," *Electrician*, January 24, 1936. P. 93.

Optics

"World's Largest Eye is Ready for Grinding," *Popular Mechanics*, March, 1936. P. 385.

"Forty Ton 'Eye'," (Photo of the 200-inch telescope), *Popular Mechanics*, March, 1936. P. 343.

"New Telescope" California Institute of Technology," *Science* Supplement #6, January 24, 1936.

Photoelectric Effect

"Sensitive Electric Eye Made from a Copper Disc," by Kenneth Murray, *Popular Science Monthly*, March, 1936. P. 72.

Photography

"Lighting for Motion Pictures," by H. C. McKay, *American Photography*, January, 1936. P. 53–54.

"Filters for Winter," by H. C. McKay, *American Photography*, January, 1936. P. 54.

"Toy or Tool? Challenge to the Miniature Cameraist," by C. S. Knapp, *American Photography*, February, 1936. P. 80–86.

"Photographs Taken from the Stratosphere," *Science*, December 20, 1935. P. 586.

"Photoelectric Exposure Meter," *Scientific American*, February, 1936. P. 103.

Polarized Light

"One-Way Light Works Optical Wonders," by Robert E. Martin. (New polarizing glass), *Popular Science*, April, 1936. P. 20.

"Polarized Light Works Magic for Camera Man," *Popular Mechanics*, March, 1936. P. 411.

"Illumination of Headlight Glass" (New optical material known as Polaroid), *Science* Supplement #6, January 24, 1936.

Radio

"A Rival of the Vacuum Tube, The Electron Multiplier," by Vladimir K. Zworykic, *Scientific American*, February, 1936. P. 168–9.

"Nobel Prize Radioactivators," *Scientific American*, February, 1936. P. 83.

"Cigar Box Portable Radio," *Popular Science Monthly*, February, 1936. P. 52.

"Elimination of Static on Radio," *Literary Digest*, February 1, 1936. P. 37.

"Does the Radio Act Hamper Research?" by H. R. Minino, *Science*, January 17, 1936. P. 54–55.

"Metal Tubes Here to Stay," by M. L. Muhlemon, *Scientific American*, February, 1936. P. 100.

"Short Wave Receiver de Luxe," *Popular Mechanics*, January, 1936. P. 101.

"Propagation of Ultra-Short Radio Waves," by Charles R. Burrows, *Bell Laboratories Record*, December, 1935. P. 11–15. Illustrated.

"A Radio Compass for Aircraft," by C. B. Aiken. *Bell Laboratories Record*, January, 1936. P. 165–168.

Roads

"Highways on the March. New Lines on the Road Map of the World," by John Ely Burchard, *Technology Review*, January, 1936. P. 138.

Sound

"Auditory Perspective," by John Mills, *The Scientific Monthly*, February 1936. P. 137.

"Oscilloscope Shows Sound Waves in Action," *Popular Science Monthly*, February, 1936. P. 57.

Spectra

"Spectral Detective Finds Tell-Tale Clews," *Popular Science Monthly*, February, 1936. P. 29.

"General Source of Radiation for the Visible and Infra-red Spectrum" by A. H. Pfund. (diagrams), *Science*, December 20, 1935. P. 597–8.

Telegraphy

"Words Made to Order for the Strange Language of the Cables," *Popular Science Monthly*, March, 1936. P. 22.

Television

"Color Pictures Sent by Television or Wire," *Popular Mechanics*, February, 1936. P. 253.

"What Now of Television?" by M. Codel, *Reader's Digest*, February, 1936. P. 43–44.

"The Telephotograph Line," by Pierre Mertz, *Bell Laboratories Record*, February, 1936. P. 178, illustrated.

"Delay Equalizers for Telephotograph Transmission," by F. A. Hinsha, *Bell Laboratories Record*, February, 1936. P. 193–197.

Textiles

"Glass Textiles offer Interesting Possibilities for Variety of Special Uses," *Textile World*, January, 1936. P. 66.

"Recently Devised Apparatus for Measuring the Strength-Elongation Properties of Yarns and Fibres," by A. J. Hall, *Textile Colorist*, January, 1936. P. 40.

Time

" 'Perpetual Motion' Clock Run by Temperature Changes," *Popular Mechanics*, March, 1936. P. 385.

Tunnels

"Glass Lined River Tunnel Built in Record Time," *Popular Science Monthly*, March, 1936. P. 34.

Transportation (Railroads)

"The Revival of Train Speeds in America," by Eric L. Crickmay, *American Travelers' Gazette*, December, 1935. P. 18.

"Locomotive Like Bullet Styled for To-morrow," *Popular Mechanics*, March, 1936. P. 350.

"Steam, and Oil Burning Diesel Locomotives," *Science*, December 13, 1935. Supplement #14.

"Mightiest Diesel Locomotive," *Scientific American*, December, 1935. P. 319.

Transportation (Steamboat)

"The Arctic Sea-Route is Open," by Anna Louise Strong, *Asia*, February, 1936. P. 94.

"Creating a New World in the Arctic," by Albert Parry, *Travel*, March, 1936. P. 38.

"What's Next in Science?" by K. T. Compton, *Vital Speeches*, January 27, 1936. P. 250–2.

REPORT OF COMMITTEE ON CURRENT EVENTS

MR. W. S. DRURY, *Chairman, Middlesex School*

When in New York

Visitors to New York will be rewarded by a trip to the New York Museum in Science and Industry, which moved in February to new quarters in Rockefeller Center. This growing technical museum, in the style of the great Deutsches Museum in Munich, has already a wealth of fine exhibits to illustrate scientific principles and industrial processes, with numerous working models which the spectator can operate for himself. Having now the financial support of the Carnegie and Rockefeller Foundations, the museum should develop into a real power for the spread of unified scientific knowledge.

The enlarged quarters were opened with fitting ceremonies, at which Dr. Albert Einstein and other notable men were present. Sir William Bragg, sitting in Faraday's chair in London, started the formal opening by striking a match and lighting a candle. The light was "heard" and changed into electric impulses, which were sent across the Atlantic by radio. Here the impulses turned on a Westinghouse lamp from the Columbian Exposition of 1893, and its light in turn actuated switches through a photoelectric cell and started two banks of the latest mercury vapor lamps.

The Visible Made Invisible

Simple optical principles put to practical use are illustrated by the invisible glass windows installed in February by Jordan Marsh Company in

Boston. While not of an entirely new type, these store windows are nevertheless still rare enough in New England to deserve the attention of anyone who happens to be near them. Their use not only increases the attention value of window displays by making every article plainly visible, but, more important to the storekeeper, it cuts the cost of daytime window lighting.

So long as plane polished glass is used, annoying reflections will result in spite of brilliant lights inside, or awnings outside. On sunny days lighting intensities to overcome glass reflections are economically out of the question, and even on dull days intensities must be around 1000 foot-candles to be at all effective. By using a specially curved plate glass which bends forward over a dark light-absorbing pocket, reflections are eliminated, and the passerby sees apparently an open display.

The Invisible Made Visible

The "iconoscope" of Dr. Vladimir Zworykin of RCA-Victor and Dr. G. A. Morton offers new possibilities for both telescopic and microscopic exploration. In this "electronic image tube," infra-red rays are focused on a film of caesiated silver oxide. The film in turn emits electrons from its face in proportion to the strength of the radiation falling on it at every point, and these electrons actuate a fluorescent screen, producing there a visible image. Thus an invisible source of infra-red rays may be made to give a visible image of itself.

More Power to New York

The largest and also one of the first hydrogen-cooled generators to be built has been ordered by the New York Edison Company as part of a new 50,000 kilowatt, 13,800 volt, 3600 r.p.m., Westinghouse superposed turbo-generator unit. The turbine will be a two-stage, non-condensing, impulse-reaction unit including a high pressure element developing 46,710 kilowatts at 1200 pounds, 900°F., 200 pounds gauge back-pressure. The main unit will be flexibly coupled to a 3290 kilowatt, feed-heating turbine operating at 200 pounds pressure at 502°F. with 5 pounds gauge back-pressure at the exhaust.

More for Boulder Dam

General Electric announces that work has begun on two more 82,500 kilovoltampere generators for Boulder Dam. One such generator is already installed, and another is being shipped. Each generator weighs more than 2,000,000 pounds, and stands 32 feet high, and at least forty freight cars will be needed to ship the two new units.

Drying by Induction

Low maintenance and operating costs, and reduced operating time with reliable high-grade results, are features of a new type of drying oven sucessfully used by the Chrysler Motor Corporation. Induction heating as related to melting and to very high temperature work is in common use but to apply it to relatively low-temperature work, and for the unique purpose of drying paint or rapidly drying wet metal parts, is quite new.

Drying paint from the inside out, by expelling the volatile products from the layer of paint next to the metal before the surface seals over, produces an excellent firm smooth film. Induction heating seems to be practically the only way of accomplishing this kind of drying on metal parts painted all over. This type of heating also has a high efficiency, as the part being processed has the heat generated right in itself. The radiation losses in the oven are low, and fire danger is minimized.

As described in a recent report from Chrysler engineers, the oven consists of a series of coils through which the metal parts being treated are conveyed continuously. To insure even heating, the induced flux must run in widely varied directions, especially in irregularly shaped parts such as wire wheels. This is accomplished by mounting the coils either vertically or horizontally, or both, in different parts of the oven. Polyphase current, 360 cycle at 440 volts, is used, it having been found that single-phase fields on fixed position parts gave very uneven heating, and proved entirely unsatisfactory for paint baking, where fairly uniform temperatures are important.

Aids for Astronomers

Aluminum, evaporated onto a previously shaped backing, has been providing more complete reflection and greater permanence than silvered surfaces. Now Dr. John Strong of California Institute of Technology, inventor of the process, has opened a new field for its application, namely, the shaping of the mirror itself by depositing the aluminum on in varying thicknesses.

By starting with a spherical surface and covering it with screening plates the aluminum can be deposited just where wanted and as thickly as wanted. Smaller or larger concentric screens are then substituted, and more metal built up. In this way the whole mirror is coated with rings of gradually increasing thickness, and the spherical surface is turned into a paraboloid or into any other desired curve.

Widening Roads by Air

An ingenious application of air pressure has been the moving of an 8 mile stretch of concrete road for a lateral distance of 12 feet. Because of the large number of accidents on one 2-lane main highway between New Brunswick and Trenton, N.J., engineers were confronted with the task of making it into a 4-lane road; and at the same time of providing a safety strip down the middle. It was decided to slide one lane sideways to make the safety gap, and then to lay a new fourth lane outside of this moved one.

The successful technique consisted in prying out the asphalt binder between two lanes of concrete slabs, and in substituting a 500-foot length of flattened 3-inch linen hose soaked in water and treated with graphite. Application of air pressure to this hose, closed at one end, forced this great length of road to slide sideways for two inches. A special double-jacket, cotton, rubber-lined, 6-inch hose was then inserted and the operation repeated for another three inches. As the gap widened, wooden beams and concrete shims supported by steel girders were introduced to back up the hose.

About five minutes was taken for one complete cycle, and 40 individual pushes were needed to move the whole distance of 12 feet. Considering that as many as fourteen separate 35-foot slabs totalling some 840,000 pounds were moved at a time with absolutely even pressure by merely opening a valve, the task becomes remarkable in its simplicity and effectiveness.

Rocket Motors Progressing

Dr. Robert H. Goddard of Clark University, authority on rocket propulsion, has developed a reaction motor which gives over 200 H.P. per pound of its weight, and provides speed up to 700 m.p.h., as announced this week by the Smithsonian Institution. Dr. Goddard, working under grants from the Smithsonian and Carnegie Institutions and from the Guggenheim Foundation, thus describes some of his findings: "The combustion chamber finally decided upon for use in flights was 5¾ inches in

diameter and weighed five pounds. The maximum lift obtained was 289 pounds, and the period of combustion usually exceeded twenty seconds. The lifting force was found to be very steady. Using the most likely value of the total mass of liquids ejected and the integral of the lift-time curve obtained mechanically, the velocity of the ejected gases was estimated to be over 5000 feet per second. This gave for the mechanical horsepower of the jet 1030 H.P., and the horsepower per pound of the combustion chamber considered as a rocket motor, 206 H.P. It was found possible to use the chambers repeatedly."

Best results have been obtained from a mixture of liquid oxygen and gasoline for fuel. Vertical flight is insured by gyroscopic control. The rockets themselves continue fairly heavy, and the maximum altitude thus far reached is less than a mile and a half. As a matter of fact, no attempt has been made to set records, and the flights have been kept down where they could be analyzed.

The scientists and aviators who are supporting this research emphasize that their interest in the liquid-propellant rocket lies purely in its possibilities as an instrument for penetrating and bringing back information on the outer atmosphere and not as a means of transportation.

Diesel Tests by B. & M.

The Boston and Maine has recently completed a series of test runs with the largest Diesel-electric locomotive ever to operate on New England roads. This new engine, lent by the Electro-Motive Corporation for the trials, is 128 feet long, nearly 15 feet high, and weighs 256 tons. It delivers 3600 H.P., and can haul the longest passenger train at speeds up to about 80 m.p.h. No public announcement has yet been made as to its acceptance or rejection by the B. & M.

First Artificial Radioactive Element

By hurling billions of deuterons at bismuth, Dr. John J. Livingood of the University of California succeeded last month in producing a tiny bit of radium *E* and polonium, thus becoming the first man to produce a natural radioactive element. Using the "cyclotron" or 5,500,000 volt electromagnetic electron "gun" designed by his co-worker Dr. Ernest Lawrence, Dr. Livingood was able to drive neutrons into a few bismuth atoms of weight 209, turning them into radium *E* with atomic weight 210. Proof that the new product is radium *E* comes from the fact that its half-life is five days, and from the fact that it emits alpha particles just as radium *E* does.

Polaroid Attracts Attention

The amazing new polarizing material developed by Boston scientists has created widespread public interest through magazine and newspaper articles, as well as through the newsreels. Members present at today's meeting will see various demonstrations of its possible uses.

DISCUSSION OF RESULTS OF MATHEMATICS TESTS GIVEN TO SCIENCE PUPILS

CHARLES B. HARRINGTON, *Newton High School*

The report which I am to give today on the results of the test in Mathematics (or rather Arithmetic), which has been given by members of this association to their classes in Physics is based on a much smaller number of pupils than I had hoped for.

We have received to date the results of this test given in six schools, including both public and private secondary schools, the total number of students having been tested being 3500. Of this number, approximately 400 are college preparatory and about 3100 are non-college or "Academic" pupils.

The average score for the college preparatory group is 80%, and for the non-college preparatory group is 48%. The average for both groups is approximately 53%.

It may be of comfort to those of us who have given the tests and may have been severely shocked at the results to learn that the scores of our pupils differed very slightly from those of other schools. There is a surprisingly low deviation from the total average.

Although the above percentages are based on a comparatively small number of tests, the uniformity of the results and the variety of schools included, justifies us in suspecting that other schools will not differ very greatly in scores from those already tested.

May I urge all who have not given this test to their pupils to do so as soon as possible and to mail their results to me. I will gladly supply special forms for the tabulation of these results.

If future returns from a much larger number of schools show averages differing but slightly from those already received we shall, I believe, be fully justified in considering, as an association, possible measures by which we may hope to bring about desired changes in the training in Arithmetic in the grades preceding the high school.

We have heard much about the advisability of presenting the subject of Physics without the use of Mathematics. The attitude of the members of this association toward this matter is clearly indicated by the returns on the question, "Do you think that Mathematics should be largely eliminated from high school Physics?" Returns to date show 94% replying strongly in the negative.

Replies from these same members to the question, "How many hours do you spend in a year teaching the arithmetic necessary to meet your requirements?", show an average of 12 hours.

These 12 hours we can ill afford to lose from the limited time which we now have for the subject of Physics.

THE OLD AND NEW IN OUR ELEMENTARY PHYSICS COURSE

By N. Henry Black

Harvard University, Cambridge, Massachusetts

First, what is *old* and what is *new* in physics? What is new today will be old tomorrow. Physics is plunging ahead at a terrific pace, and every teacher, I am sure, feels the urge to keep up with the new physics and to try to get his students acquainted at least with its vocabulary, which is penetrating even to the daily press.

At this time of the year we doubtless all feel a little tired of the old humdrum drill that has to be done on the fundamental principles in our regular physics course. It is difficult to see how to put new life into the laws of the lever, into the equation for kinetic energy, into the heat equations, into Ohm's law, or Joule's law, or into the lens and mirror equations. Yet all of these things have to be reviewed again and again in order that our students may be able to use them.

There is however, one suggestion which I should like to make in regard to putting new life into this old fundamental material. Last year a book

was published called *A Source Book in Physics*, by William Francis Magie, Professor Emeritus of Physics at Princeton University. (McGraw-Hill Book Company.) This, as its title suggests, contains translations and reprints of some of the classical literature in experimental physics. There are brief—perhaps too brief—sketches of the lives of the great physicists. It is stimulating, when teaching, let us say, the mechanical equivalent of heat, to be able to read Joule's own experiment in this field or the early experiments of Rumford on the production of heat by friction. In discussing the speed of light, it is a great convenience to be able to turn to the original papers of Roemer, Bradley, Fizeau, or Foucault on measuring the velocity of light. I am sure that this book, while it seems big and bulky, will prove very useful to every physics teacher, and to the gifted student it will be an inspiration and a mine of information.

I have already said that the contents of our elementary physics course is rapidly expanding. One has merely to compare textbooks of today with those of twenty-five years ago. A few days ago I received a copy of the revised edition of *A Survey of Physics for College Students* by my colleague, Professor Frederick A. Saunders. (Henry Holt and Company.) This I shall take as an example of one of the new books. As an example of an older textbook in this same field, let us take Kimball's *College Physics*, first published just twenty-five years ago. An easy way of finding the new material in Saunders' book is to examine the index and then compare it with that of Kimball. I presume that there are more than a hundred topics in the new book which are not even mentioned in the old, but I have picked out only twenty-five that have interested me personally and about which I was eager to read what Saunders had to say. They are as follows:

	Page
1. Artificial radioactivity	659
2. Artificial disintegration	655
3. Compton effect	631
4. Cosmic rays	661
5. Ionosphere	498
6. Isotopes	475, 650
7. Magneto-striction	407
8. Mass spectrograph	475
9. Neutrons	656
10. Photoelectric cell	638
11. Photons	580
12. Planck's constant	581
13. Positrons	657
14. Protons	655
15. Quantum theory	192, 580
16. Raman effect	631
17. Relativity	662
18. Seismograph	269
19. Skip distance	499
20. Super-conductivity	360
21. Supersonics	284, 490
22. Thyratrons	494
23. Tracks of atoms	653
24. Wave-mechanics	633
25. "Wired wireless"	495

Now I am not even suggesting that these topics should be included in every high-school course in physics, but I am sure that every high-school teacher of physics will want to get the last word on them. Some of them are

theoretical and some of them are old but applied in a new way. I am sure that everyone will want to consider carefully whether any of this new material will be useful in his own instruction.

All of us admit today that one of our troubles in elementary teaching is that our textbooks are too comprehensive. This is because the authors have tried to include all of the old and much of the new physics. The books are big in words, big in volume, and big in facts. The student is lost and oftentimes the teacher is bewildered. *What are the results?* First, our courses are inclined to be, and I am sure in many cases are, very superficial. We jump from one topic to another with insufficient time for the subject to be applied and digested. I fear also that there is too little real work done in good old-fashioned mechanics. In order to get into atomic physics we neglect the law of the parallelogram of forces. What is worse, I think we are also likely to lose the point of view of experimental physics, forgetting that physics is not only a mathematical science but also a science based on experiments. This leads to an even more unfortunate situation: we lose in our teaching, and the student loses in his study, the inductive spirit of trying to solve nature's riddles. I have sometimes observed that, in their eagerness to grasp the latest discovery in regard to the structure of the atom teachers have apparently lost the connection between elementary physics in school and the student's everyday experience. This is surely one of the main reasons for teaching physics in our high-schools. If we have lost this, we have lost our excuse for existence.

What are we going to do about it? First, I assume that we teachers will not, because of the above reasons, stop studying physics, modern physics, atomic physics, the new physics. That is one of the great incentives in studying and teaching physics, that every year we have a new science, new developments, new discoveries, and we have to keep ourselves constantly alert to adjust our conceptions to new theories and to understand new experiments. Next, we naturally are going to study carefully these new topics with the idea of seeing which ones are adapted to our own elementary courses. This is largely a question of trial. This year we introduce one topic, next year we try some other topics, always keeping in mind, however, that if we add some new physics, we must also drop out some of the old. That, I take it, is the hardest part of the whole problem. What is it that we can afford to drop out? I confess I don't know! Another point, it seems to me, is that in trying to become acquainted with the new physics and the new theories, we, as teachers, must be sure that we master the experimental facts which lie back of the new conceptions. The newspapers and the popular magazines very often give, in a somewhat garbled fashion, merely the results. But if we are to use this material effectively in the class room, we must know on what experimental basis it rests.

Finally, I would urge that we must not forget that "modern physics" means more than "atomic physics." For example, I am sure that we should include in "modern physics" the *high-pressure physics* which has recently been developed to such an extent by Professor P. W. Bridgman in the Harvard laboratories. In considering the application of physics to everyday life we should include the subject of *air conditioning*. There is an excellent book on this subject by Moyer and Fitz. For some years there have been going on at Leyden, Holland, epoch-making experiments in *low-temperature physics*, led by the late Professor Onnes. A very good résumé of this work is given in A. W. Barton's *Heat*. In speaking of the speed of light, one would surely want to read about Michelson's last experiment on the *speed of light in vacuum*. This work was completed and written up by Pease and Pearson and is published in the July number (1935) of the *Astrophysical Journal*. In the subject of acoustics there are two topics

which interest all of us, the *audiometer*, as developed in the Bell Laboratories, and *architectural acoustics*, a science started right here at Harvard by the late Professor Sabine. An excellent discussion of the results of this work is given in a new book, *Modern Acoustics*, by A. H. Davis. You are doubtless all familiar with the experiments by Professor Van de Graaff on *high-tension generators* that are now in progress at the Massachusetts Institute of Technology. In Berkeley, California, Professor E. O. Lawrence, with the help of an enormous electromagnet, has also been able to accelerate *hydrogen ions*, *deuterons*, *neutrons* or *alpha particles* with energies expressed as millions of volts. These experiments are of course primarily devised for furnishing a high potential for atom-smashing experiments.

But whatever we do, we want to leave our students with the idea that *physics is a growing and a practical science.*

Mr. Abraham Krasker, instructor in Visual Education at Boston University, spoke of the use of visual aids in education. He touched upon the educational philosophy of the subject and showed how visual aids could be used to especial advantage in the teaching of Physics. He demonstrated with reflectoscope, lantern slides, film slides, silent moving pictures and moving pictures with sound. The address was of great value to the members who were present.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

NOTE. Persons sending in solutions and submitting problems for solution should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solutions.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

1436. *Proposed by Cecil B. Read, Wichita, Kan.*

If $x+y+z=xyz$, prove

$$\frac{2x}{1-x^2}+\frac{2y}{1-y^2}+\frac{2z}{1-z^2}=\frac{2x}{1-x^2}\cdot\frac{2y}{1-y^2}\cdot\frac{2z}{1-z^2}.$$

First Solution

Solution by M. W. Keller, Troy, Ohio

$$\frac{2x}{1-x^2}+\frac{2y}{1-y^2}+\frac{2z}{1-z^2}=\frac{2x(1-y^2)(1-z^2)+2y(1-x^2)(1-z^2)+2z(1-x^2)(1-y^2)}{(1-x^2)(1-y^2)(1-z^2)}$$

$$=\frac{8xyz}{(1-x^2)(1-y^2)(1-z^2)}$$

$$=\frac{2x}{1-x^2}\cdot\frac{2y}{1-y^2}\cdot\frac{2z}{1-z^2}.$$

Second Solution

By Norman Anning, University of Michigan

If $x+y+z=xyz$, it is seen that

$$(1+ix)(1+iy)(1+iz)\equiv(1-ix)(1-iy)(1-iz) \tag{1}$$

since each product equals $1-yz-zx-xy$.

Square both sides and divide through by $(1-x^2)(1-y^2)(1-z^2)$ since, by the conditions, this product is not zero. We obtain

$$\left(1+i\frac{2x}{1-x^2}\right)\left(1+i\frac{2y}{1-y^2}\right)\left(1+i\frac{2z}{1-z^2}\right)$$
$$=\left(1-i\frac{2x}{1-x^2}\right)\left(1-i\frac{2y}{1-y^2}\right)\left(1-i\frac{2z}{1-z_2}\right). \tag{2}$$

From the fact that the coefficient of i in the left member equals the coefficient of i in the right, it follows that the required sum of the given terms equals their product.

Third Solution

The proposer calls attention to a solution of this problem in Loney's Plane Trigonometry by making use of the following substitution: $x=\text{Tan } A$, $Y=\text{Tan } B$, $z=\text{Tan } C$. From the given condition of the problem $A+B+C=n\pi+\pi$, n an integer, which leads to the identity:

$$\text{Tan } 2A+\text{Tan } 2B+\text{Tan } 2C=\text{Tan } 2A \text{ Tan } 2B \text{ Tan } 2C.$$

The solution easily follows from this identity.

Solutions were also offered by Hugo Brandt, Chicago, Carl Holtom, West Lafayette, Ind., Samuel H. Barkan, Brooklyn, Charles W. Trigg, Los Angeles, Everett, Wenger, Bethel College, Kansas, A. J. Patterson, Wheeling, W. Va., James V. Bernardo, Bragtown, N. C., Max Fowler, Centralia, Ill., Aaron Buchman, Buffalo, Chas. C. D'Amico, Albion, N. Y. and the proposer.

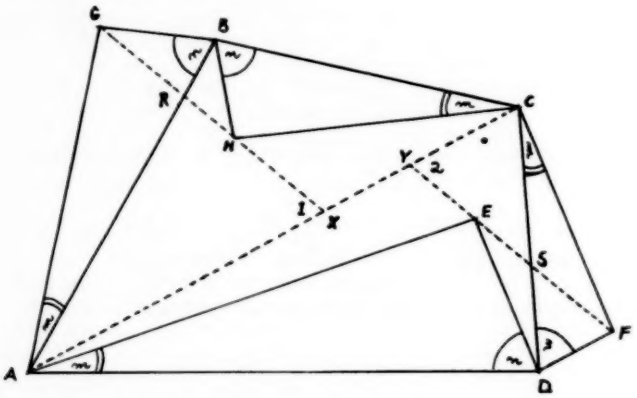
1437. *Proposed by Alvin Meyrowitz, Ithaca, N. Y.*

A quadrilateral $ABCD$ is given with similar triangles ABG, BCH, CDF, DAE. Triangles ABG and CDF are external to the quadrilateral while the other two are internal. The four angles of the triangles at A and C are equal, and also the angles at B and D are equal. Prove that $GEFH$ is a parallelogram.

Solution by Aaron Buchman, Buffalo, N. Y.

Draw diagonal AC and let GH cut it at X and let FE cut it at Y. Since $\Delta ABG\sim\Delta BCH$, it is easily shown that $\Delta GHB\sim\Delta ABC$ and $\angle BGH=\angle BAC$

Then in $\triangle GBR$ and ARX, $\angle 1 = \angle GBR = \angle n$.
Similarly $\angle 2 = \angle n$, $\therefore \angle 1 = \angle 2$ $\therefore GH \| FE$
Similarly, by drawing diagonal BD, we can show that
$GE \| HF$
$\therefore GEFH$ is a parallelogram



Solutions were also offered by W. E. Buker, Leetsdale, Pa., David Blumstein, Brooklyn, D. F. Wallace, Minnesota, Charles W. Trigg, Los Angeles, Seymour J. Sherman, New York, Everett Wenger, Bethel College, Kansas, A. J. Patterson, Wheeling, W. Va., and Hugo Brandt, Chicago.

1438. *Proposed by Rabbi Carl Manello, Youngstown, Ohio.*

An army twenty-five miles long marches forward. A messenger in the rear of the army starts out with a communication to the head of the army. He delivers the message, and starts back to the rear. By the time he returns, the rear of the army has reached the spot where the head was when he started out. How many miles did the messenger walk?

Solution by Chas. C. D'Amico, Albion, New York.

Let x = distance army marches until messenger delivers the communication to the head of the army.
Then $25+x$ = distance messenger travels when army travels x miles
Then $25-x$ = remainder of distance army marches when messenger has returned to the rear.
Then x = distance messenger travels to reach the rear
Thus,

$$\frac{x}{25+x}=\frac{25-x}{x} \qquad 2x^2=625$$

$$x^2=625-x^2 \qquad x^2=312.5$$

$$x=17.675 \text{ miles.}$$

Therefore, messenger travels $25+2\ (17.675)=60.35$ miles

Solutions were also offered by Hugo Brandt, Chicago, A. J. Patterson, Wheeling, Everett S. Wenger, Bethel College, Kansas, Bob Riebuidson, Spokane, Wash., Charles W. Trigg, Los Angeles, W. R. Smith, Chicago, W. E. Buker, Leetsdale, Pa., Fr. A. Panll, Quincy, Ill., Margaret Dyar, Spokane, Wash. Seymour J. Sherman, New York, Max Fowler, Centralia, Ill., Hobson M. Zerbe, Wilkes-Barre, Pa., and John N. Meighan, Harpers Ferry, W. Va.

1439. *Proposed by Norman Anning, University of Michigan.*

If a and b are 2 integers (not alike) 3 integers can be found, x, y, z, such that $x+y=a^2+b^2$ and $yz+xz+xy=z^2$.

Solution by Charles W. Trigg, Cumnock College, Los Angeles.

$a^2+b^2\equiv a(a+b)+b(b-a)$. Hence in the first equation we may let $x=a(a+b)$ and $y=b(b-a)$. Substituting these values in the second equation we secure, $z^2-(a^2+b^2)z-ab(a+b)(b-a)=0$. $[z-b(a+b)][z+a(b-a)]=0$. Whereupon, $z=b(a+b)$ and $z=-a(b-a)$. Now since a and b are integers, integral values of x, y, and z satisfying the two equations have been found.

Solutions were also offered by Hugo Brandt, Chicago, D. F. Wallace, Minnesota, and the proposer.

1440. *Proposed by Dewey C. Duncan, Compton, Calif.*

A straight bar of iron 800 feet long expands 8 inches. If the two ends are immovable and the resulting form is a circular arc how far does its midpoint move?

Solution by Chas. C. D'Amico, Albion, New York.

Arc $=\frac{1}{3}(8b-a)$ where b is the chord of $\frac{1}{2}$ the arc and a is the chord of the whole arc.

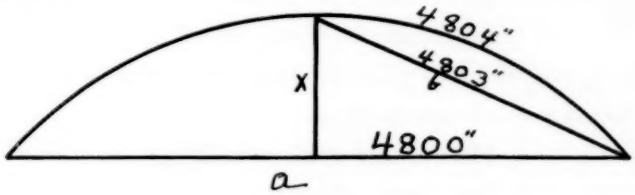
$\widehat{AB}=9608$ in. Therefore, $9608=\frac{1}{3}(8b-9600)$ and $a=4803$ in.

Therefore, $x^2=\overline{4803}^2-\overline{4800}^2$

$x^2=28809$

$x=169.7$ in., height of arc or distance midpoint moves.

Solutions were also offered by Hugo Brandt, Chicago, Arthur Danzl, Collegeville, Minn., W. P. Smith, Chicago, Ellery C. Kilbourn, Waterbury, Conn., John N. Meighan, Harpers Ferry, W. Va., and Chas. W. Trigg, Los Angeles.



1441. *Proposed by Joseph L. Stearn, Washington, D. C.*

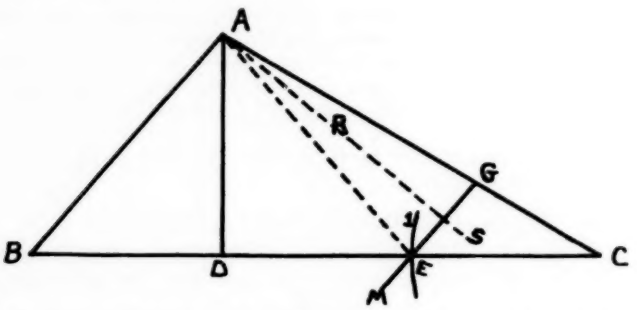
Construct a triangle given the difference between the base angles, the difference of the sides issued from the base and the difference of the segments formed on the base by the altitude on the base.

Solution by James A. Lemon, Englewood, Ohio.

This problem is identical with Ex. 2, page 31 of "College Geometry" by Nathan Altshiller-Court, which is: Construct a triangle, given: $p-q$, $b-c$, $B-C$.

1. Draw $GC=b-c$.
2. Construct angle $CGM=90°+\frac{1}{2}(B-C)$.
3. Draw arc 1 with center C and radius, $p-q$, intersecting GM at E.
4. Draw RS, the perpendicular bisector of EG, and extend RS until it intersects CG produced. Point of intersection is A.

5. From A, drop a perpendicular to CE produced, meeting CE at D.
6. With radius ED, and center D, mark off $BD=ED$ on CD produced.
7. Draw AB.
8. ABC is the required triangle, since $p=DC$, $q=BD$, $GC=b-c$, angle $EAG=B-C$, and $EC=p-q$.



Solutions were also offered by Chas. C. D'Amico, Albion, N. Y., Maxwell Reade, A. J. Patterson, Wheeling, W. Va., Bernard Alfred, Brooklyn, L. B. Aseltine, Joliet, Ill., W. E. Buker, Leetsdale, Pa., Rosalma Newbauer and Hiltrude Braulich, Waverly, Iowa, D. F. Wallace, Minnesota, Chas. W. Trigg, Los Angeles.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

1436. Clara and Ruth Straight, Kirksville (Mo.) H.S.

1436, 8. Richard Bellman, Abraham Lincoln H.S. Math. Team.

1437. Harold Sogin, Tilden Technical (Chicago) H.S.

PROBLEMS FOR SOLUTION

1454. *Proposed by Hugo Brandt, Chicago.*

Divide a circle by two parallel lines into three parts of equal area.

1455. *Proposed by D. McLeod, Winnipeg, Manitoba.*

In a circle AB is any chord, with O its midpoint. EOF and COD are any other chords. If ED cuts AB at X and DF cuts AB at Y, prove $OX=OY$.

1456. *Proposed by Isadore Chertoff, Bayonne, N. J.*

If $ax^2+bx+c=0$, the six equations that can be found by interchanging the coefficients will have rational roots if $a+b+c=0$.

1457. *Proposed by Algebra IV, Lewis and Clark High School, Spokane, Washington.*

A man received a check for a certain number of dollars and a certain number of cents. The person cashing it for him gave him a number of dollars equal to the number of cents he should have received and a number of

cents equal to the number of dollars he should have received. He spent $3 and then found he still had three times the amount of money the check called for in the first place. For what amount was the check written?

1458. *Proposed by D. F. Wallace, Minnesota.*

BC, the chord of a circle equal to its radius, is one side of an equilateral triangle whose other vertex, A is outside the circle. Show that if D is any point on the circle $AD^2 = BD^2 + CD^2$.

1459. *Proposed by Cecil B. Reade, University of Wichita, Kansas.*

The area of a quadrilateral which can be both inscribed in a circle and circumscribed about another circle is $\sqrt{abcd}$.

SCIENCE QUESTIONS

June, 1936

Conducted by Franklin T. Jones,
10109 Wilbur Avenue, Cleveland, Ohio

Readers of School Science and Mathematics are asked to contribute: Questions, Answers, Comments, Suggestions—Whatever is new or interesting in the teaching of Science.

Wanted—Your final examination papers. Thanks! Mail them.—Do it now.

FOR FALL—1936

1. What are you going to do in Science that you did not do in 1935?
2. What do your pupils talk about in the way of science?
3. Are pupils and teachers agreed as to what is interesting?
4. Are pupils better posted on science than they used to be?
5. What do you use in class from the "Science advertising" used by Sinclair and other Merchandisers?
6. Are we making real progress in the teaching of science?
7. Are pupils of today better or worse than thirty years ago?
8. What can "Science Questions" do to be of more use to a larger number of readers?

FOR SUMMER—1936

The Great Lakes Exposition at Cleveland

1. Are you coming to Cleveland this summer? Be sure to give the Editor a ring CHerry 1000, or REpublic 0755W or drop him a card—900 Union Trust Bldg., or 10109 Wilbur Avenue, SE (There might be a limited space in his house for a member or two of the GQRA). The Chicago exposition had a wonderful "science" exhibition. Although still an unknown quantity, Cleveland will aim to equal or surpass.

Light at Great Lakes Exposition

2. General Electric is going to talk light at the Great Lakes Exposition this summer. Having run out of human specimens for the moment it has decided to show what happens in the animal world over a few eons if animals don't use their eyes or don't use them properly.

Purchasing Order 7,332, received from the General Electric Institute by the Nela Park purchasing staff, read:

Please secure at once, for delivery alive, the following:
One wise owl.
One blind mole.
One blind crawfish, typical of those found in Mammoth Cave.
One tropical fish with bulgy eyes.
One bat (not baseball) but ugly. (P. S. that flies.)

It was set forth for the edification of the purchasing department, which is not expected to be scientifically grounded, that the owl has the sagacity of nocturnal birds and does not use its eyes except in the shadows as nature intends.

The bat is smart enough not to subject its vision to the brilliance of broad daylight, seizing insects in the twilight and the murk of night The specified crawfish lost his sight and his eyes, too, his ancestors having been trapped in Mammoth Cave back in glacial days. Folk should know, said the scientist, that the mole just naturally preferred a subterranean career and paid the price of it with his sight.

Perhaps the moral is clear. If not, you are advised to go to the exposition's light displays and learn. (The Editor might elect one Roelif Loveland of the *Cleveland Plain Dealer* to the GQRA because supposedly he wrote the above.)

NEAR EXPLOSION IN COURT ROOM

762. *From a News Item.*

In a court room in Cleveland (February 20, 1936) one Clausen on trial for robbery, held up a two-ounce vial of a "clear liquid" and said, "I am going to die here. If anyone tries to shoot me, you'll all go with me." Clausen usually escaped after one of his robberies by threatening to smash a vial of nitroglycerine at the feet of the persons he robbed.

Sergeant Ryan shot him in the hand holding the vial and he went down smashing the vial on the floor. Bystanders said there was a distinct "aroma of ammonia."

In the wake of the tumult the question arose: "What if Clausen had possessed a two-ounce vial of nitroglycerine and had smashed that high explosive? What would have happened?"

MECHANICS OF A FLEXIBLE ROPE

763. *The American Physics Teacher* **3,** *85 (1935) and* **4,** *43 (1936), (Professor W. W. Sleator and Professor Raymond T. Birge) Professor Sleator proposed the following problem:*

"Uniform and flexible rope of mass 2 lb/ft. is drawn from a stationary coil by a man who walks at the rate of 5 ft./sec. directly away from the coil over a smooth and level floor. He thus drags after him an increasing length of rope. What horizontal force must the man exert on account of the inertia of the rope?"

Who has a solution? Some get 50 poundals, some 25 poundals as answers.

"PROBLEM NO. TWO"

764. *Proposed by Charles C. D'Amico.* (GQRA No. 49), *Albion High School, Albion, N.Y. "Problem No. 1" was proposed by Mr. D'Amico in January,*

1935, as No. 681. Mr. Louthan recently sent in a solution which is published elsewhere in this number. Here is "Number Two."

A battery of twelve equal cells, in series, screwed up in a box, being suspected of having some of the cells wrongly connected, is put into a circuit with a galvanometer and two cells similar to the others. currents in the ratio of 3 to 2 are obtained according as the introduced cells are arranged, so as to work with or against the battery. What is the state of the battery? Give reasons for your answer.

765. *Submitted by Professor R. T. Harling,* (GQRA. No. 68) *Memorial University College, St. John's, Newfoundland.*

PHYSICS I

3 hours. Half-Year Exam. 1936: *Answer eight questions.*

1. Describe any way in which you could measure the acceleration of a freely falling body.

What effect does the air have on the motion of such a body?

A motor car initially moving at 10 cms. per second commences to accelerate at the rate of 5 cms. per second per second.

a) What does the statement mean, exactly?

b) What speed will the car have after 10 seconds?

c) How far will it have gone in this 10 seconds?

2. State Newton's second law of motion. Define the "dyne" and show that the weight of one gramme mass is 981 dynes.

The car in question (1) has a mass of 1000 kgms. Find the force the engine must provide to give the acceleration of 5 cms. per sec. per sec.,

a) if the bearings etc., in the car, are all frictionless.

b) if a frictional force of 50 kgms-wt. is opposed to the motion of the car.

3. What is a "vector?" Explain how the process known as "vector addition" is carried out.

Telephones wire are sometimes broken by the ice which collects on them. In which case is there greater danger of breakage, when the wires are tight, or hung with a considerable sag? Give a careful explanation based upon a knowledge of vector diagrams.

4. Define "momentum" and state the "Principle of Conservation of Momentum" for two colliding bodies.

Two perfectly elastic spheres having masses in the ratio 3:1—are suspended freely by strings of equal length. They are drawn back through equal arcs and released so that they collide with equal speeds, and rebound. Describe and explain what happens in the series of collisions which follows.

5. Define "erg," "joule," "watt." A motor car of mass 1000 kgms. has a speed of 10 cms. per second. Find the work the engine must do

a) to drive the car for five minutes along a level road, against a frictional resistance of 50 kgms-wt.

b) to drive the car 5000 metres along an up-grade of one in twenty (neglecting friction)

c) to increase the speed of the car to 20 cms. per sec.

6. A balloon having a fixed volume of ten million litres is filled with hydrogen (density .1 gms. per litre) at the earth's surface, where the density of the air is 1.3 gms. per litre and its pressure 76 cms. of mercury. The weight of the fabric and other material of the balloon is 2000 kgms.

Explain why the balloon rises when released, stating the famous principle involved, and calculate the lifting force. Explain also why the balloon ultimately ceases to rise further, and find the air pressure at its

"ceiling." (Assume that there are no temperature changes to be considered.)

7. Explain the following:—

a) "Pyrex" glass will stand sudden changes in temperature that ordinary glass will not.

b) When a building burns, windows in neighbouring buildings are frequently broken.

c) The bore of a thermometer is made very small.

d) Road surfaces are often broken up by alternate freezings and thawings.

e) A piece of wood floats in water at 5° C. On raising the temperature to 30° C, rather less/more of the wood is above the water surface.

8. Explain the following:—

a) Large vessels of water placed in vegetable cellars will sometimes keep the vegetables from injury by freezing.

b) A snowball cannot be made unless the snow is at or very near to its melting point.

c) Silver and gold coins are made by stamping and not by casting.

d) An open vessel is filled to the brim with water, and a large piece of ice floats in the water with a part projecting above the surface of the water and the edge of the vessel. Will the water overflow as the ice melts?

e) Water can be cooled by putting it in porous bags or eathernware receptacles which stay moist on the outside, and exposing it to a breeze in a dry atmosphere.

9. Define "calory," "specific heat of a material." Water has a specific heat which is high compared with that of other common substances. Of what practical importance is that fact? In what other ways is water an unusual material, and of what consequence are its peculiarities?

10. At 76 cms. of mercury pressure and 0°C temperature, 1 litre of air weighs 1.3 gms. Find

a) what volume this air will have if the pressure on it is trebled,

b) what its volume will be (subsequently to (a)), if its temperature is raised to 273°C.

c) what its density will now be.

d) to what volume it must be expanded or compressed to restore its density to its original value, the gas being kept at 273°C.

11. Give a numbered list of the chief properties of a magnet. (Half a dozen distinct properties will be enough to gain full marks.)

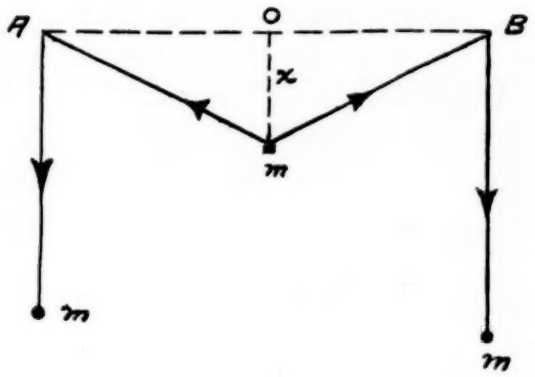
WHO IS "INTERESTED," OF NEWARK, N.J.

(*"Interested" is unknown by name. Please write to the Editor and receive an election to the GQRA.*)

"If you think it suitable for your department Science Questions, in School Science and Mathematics I should like to submit the following question which I recently ran across in connection with some outside reading. It is Problem 38a, page 124, of Principles of Electricity by Page and Adams as follows:

766. Three poles $-m$, $2m$, $-m$ are placed on the x axis at distances -1, 0, 1 from the origin. Find the potential at a distance r from the origin large compared to l, denoting the angle between the radius vector and the X axis by Θ.

Ans. $ml^2/r^3\ (1-3\ cos^2\ \Theta)$. *How obtained?*



681. *Proposed by Chas. C. D'Amico, (GQRA. No. 49.) Albion, N.Y.*

A fine string passes thru two small fixed rings, A and B, in the same horizontal plane, and carries equal weights at its ends, hanging freely from A and B. If a third equal weight is attached to the middle point of the portion AB of the string, and is let go, prove that it will descend to a depth equal to two-thirds of the length of AB below AB, and will then ascend again.

Solution Charles P. Louthan. (Elected to GQRA. No. 146) 78 West First Avenue, Columbus, Ohio.

Here, neglect the mass of the string, and the friction on the rings.

Measure x downward from O, and let this be the positive direction.

The acceleration of the middle mass is mg minus that of the other two projected on Om. Let $AO=OB=a$. The accelerations along mA and mB are mg, and we have

$$m\frac{d^2x}{dt^2}=mg-2mg\ \frac{x}{\sqrt{a^2+x^2}}$$

or

$$\frac{d^2x}{dt^2}=g-2g\ \frac{x}{\sqrt{a^2+x^2}},$$

and

$$x=0,\quad \frac{dx}{dt}=0\quad \text{at}\quad t=0.$$

Thus

$$\left(\frac{dx}{dt}\right)^2=2gx-4g\sqrt{a^2+x^2}+4ga.$$

We wish to find when $dx/dt=0$. Thus

$$2gx-4g\sqrt{a^2+x^2}+4ga=0$$

or

$$x-2\sqrt{a^2+x^2}+2a=0$$

or

$$x=0$$

$$x=4a/3$$

The mass in the middle will ascend again since the acceleration is negative at $x=4/3a$.

This distance is two-thirds of the length of AB below AB.

BOHR'S THEORY OF VALENCE

749. *Proposed by James Ashley (Elected to GQRA, No. 130), Salmon, Idaho.*

1. How do the elements 57–71 (rare earths) fall in line in the Periodic Table of the elements?

What groups do they fall in across the table?

Do these rare earth elements conform to the electronic theory, which states that each succeeding element has one more electron than one preceding it?

2. If known, what are the valences of Alabamine (Ab), Actinium (Ac), Proto-actinium (Pa), and Rhenium (Re)?

3. What is the atomic weight of Masurium (Ma)?

"If these questions are at all answerable, I would be glad to hear from you."

Report of Interview with Dr. Harold S. Booth, (Elected to GQRA, No. 147.), Associate Professor of Chemistry, Western Reserve University, Cleveland, Ohio.

(Note: Dr. Booth and his students have discovered approximately fourteen new gaseous compounds of Fluorine.)

"The answers to these questions are largely a discussion of the Bohr Theory of Atomic Structure. An excellent explanation is to be found in *Electronic Theory of Valency* by N. V. Sidgwick, Oxford University Press, 1929.

The Bohr Table of the Elements is found on page 39. The Configuration of Electrons and Atomic Structures is found on pages 47–50.

Brisco *General Chemistry for Colleges*, published by Houghton Mifflin & Co. also contains a discussion of the Bohr Theory beginning on page 238.

As to valences:—

Alabamine is not yet accepted.

Actinium (Ac), 111; Proto-actinium (Pa), No. 91, Valence 5;

Rhenium (Re) No. 75, Val. 7 (Variable like Manganese);

Masurium has the atomic number 43. Its valence can be found from the table."

ELECTRICAL MAGIC

753. *Proposed by Kenneth P. Kidd, Sweetwater High School, Sweetwater, Tenn.*

"I have been trying to make up an electrical stunt for entertaining purposes. I am sure this stunt will work well and mysteriously: but have been unable to construct it. (See sketch in April issue of SCHOOL SCIENCE AND MATHEMATICS).

When A is inserted into tube B around which is wound a wire carrying AC, the light C must burn. No contact is made between wire on A and that on B. This operates on same principle as transformer.

Do I need a condenser or induction coil? Must the hollow tube B and the rod A be metal? Can you help me soon?"

Answered by Wm. A. Porter, (Elected to GQRA, No. 148).

I noticed the call for help No. 748 in your column which I read religiously but as religiously neglect to contribute to.

Am breaking a precedent however and am enclosing a true-false test *covering* Electricity. I fear the coverage is somewhat patchy but it may be of some use. (This will be published later. ED.)

Does this entitle me to a membership *in GQRA*??? (*N.B.—You are elected*!!!)

In regard to 753. I have constructed such a device (with variations). A coil was wound on a laminated core, 4″×4″×12″ long and contained 6 layers of no 120 c.c. wire. This draws about 20 amps without any resistance ballast. A second coil was wound in a small wooden box around a core of nails previously varnished. The second core was 1¼″ diameter by 1½″ long. The secondary coil has about 2000 turns of no. 30 D.C.C. wire. The coil which was wound around the core of nails was then fitted into a small wooden case and the leads brought out through the top. A small flashlight bulb socket is mounted on the case and a bulb inserted. The whole thing is then dipped into melted paraffin to protect the device. After this treatment the secondary may be placed in a beaker of water and when the beaker is brought near the primary or induction coil the bulb will glow brilliantly.—Too bright if it is brought too close as I've burned out several that way. The demonstration is still more spectacular if the primary is enclosed in a box or mounted under a table.

TO ALL 148 MEMBERS OF THE GQRA

Meet me at Cleveland on Saturday, August First, and we'll all go down to Pen 'Bryn at Geneva, Ohio, and have a

SCIENTIFIC PICNIC

Yours for August First—
Ed Jones.

INTENSE SOUND CREATES LIGHT IN LIQUIDS

Intense audible sounds have been found to produce visible light in fourteen different liquids in the spots where cavitation occurs, said Dr. L. A. Chambers of the University of Pennsylvania Medical School, before the American Physical Society meeting at Washington.

Cavitation is the phenomenon occurring in water, for example, at the blades of swift-moving ship's propellers. Holes or empty spaces are created in tiny spots within the fluid. These evacuated spaces collapse suddenly and the liquid comes together with an impact which causes a high, momentary increase in pressure. The resulting effect in the case of propellers is a pitting and erosion of the metal surfaces. Steam turbine blades face the same difficulty.

Dr. Chambers creates the cavitation holes in his experimental liquids by the intense audible sounds with frequency ranging from 1,000 to 9,000 cycles per second.

In the regions where the cavitation was occurring he found that visible light is emitted by the liquid. An adequate explanation is still lacking but it seems probable that the atoms of the fluid are sufficiently excited in the process to emit light.

Science is teaching man to know and reverence truth and to believe that only as far as he knows and loves it can he live worthily on earth, and vindicate the dignity of his spirit.—*Moses Harvey.*

BOOKS RECEIVED

Business Mathematics, by Cleon C. Richtmeyer, Professor of Mathematics, Central State Teachers College, Mt. Pleasant, Michigan, and Judson W. Foust, Assistant Professor of Mathematics, Central State Teachers College, Mt. Pleasant, Michigan. Cloth. Pages xii+250. 13.5×20 cm. 1936. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.00.

General Chemistry, by Horace G. Deming, Professor of Chemistry, University of Nebraska. Fourth Edition. Cloth. Pages xiii+769+5. 13.5 ×21.5 cm. 1935. John Wiley and Sons, 440 Fourth Avenue, New York, N. Y. Price $3.50, plus postage.

Social Biology, by Everett P. Walton, and Philip E. Foss, Department of Biology, Hartford Public High School, Hartford, Connecticut. Cloth. Pages xv+572. 13.5×19 cm. 1936. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $1.68.

Practical Mathematics, by N. J. Lennes. Cloth. Pages xi+400. 13×20 cm. 1936. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.20.

Plane and Spherical Trigonometry, by H. L. Rietz, Professor of Mathematics, University of Iowa; J. F. Reilly, Professor of Mathematics, University of Iowa; and Roscoe Woods, Associate Professor of Mathematics, University of Iowa. Revised Edition. Cloth. Pages xi+168+72+xiii. 14×21.5 cm. 1936. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.00.

Descriptive Geometry, by C. H. Schumann, Jr., Associate Professor and Executive Officer, Department of Drafting, Columbia University. Second Edition. Cloth. Pages xi+336. 15×23 cm. 1936. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.75.

Materials of Industry, by Samuel Foster Mersereau, Chairman, Department of Industrial Processes, Brooklyn Technical High School. Revised Edition. Cloth. Pages xviii+541. 13.5×21.5 cm. 1936. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $2.00.

Theoretical Mechanics—Dynamics of Rigid Bodies, by William Duncan MacMillan, Professor of Astronomy, The University of Chicago. First Edition. Cloth. Pages xiii+478. 15×23 cm. 1936. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $6.00.

Teachers Manual for Science in the World of Work, Volumes I and II, by Frank R. Deming, Coordinator, State Trade School, Meriden, Conn.; Chairman Connecticut Curriculum Committee on Related Science; and Joseph T. Nerden, Head of the Department of Mathematics and Science, State Trade School, Meriden, Conn., Connecticut Curriculum Committee on Related Science. Paper. 47 pages. 21.5×27.5 cm. 1936. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price 25 cents.

Anekdoten Aus Dem Leben Deutscher Mathematiker von Johannes Mahrenholz, Studienrat an der Adolf-Hitler-Oberrealschule in Cottbus. Paper. 44 pages. 12×18.5 cm. 1936. B. G. Teubner, Leipzig, Germany. Price RM 1.20.

Die Neuen Arbeitsräume der Hauptstelle als Muster für Bauberatung. Paper. 136 pages. 1936. Quelle and Meyer, Leipzig, Germany. Price RM6.

Mathematik Enthaltend die Besonders an Seltenen Mathematischen Büchern Des 15. Bis 18. Jahrhunderts Reichhaltige Bibliothek Des Geh. Rats Prof. Dr. A. Pringsheim-München. Paper. 148 pages. 14×22 cm. Buchhandlung Gustav Fock, Leipzig, Germany.

BOOK REVIEWS

Practical Problems in Botany, by Wilfred W. Robbins. Professor of Botany, University of California and Jerome Isenbarger. Head of Department of biological science, Wright City Junior College, Chicago. ix+402 pages, 230 figures. 13.5×20.5 cm. Cloth. Published by John Wiley & Sons, Inc., New York. 1936. Price $2.00.

The authors of this book are unusually well prepared for the task they set out to do. Professor Robbins is the author of "Botany of Crop Plants," a book well known to teachers of botany and horticulture. It is by far the best book of its class published. Mr. Isenbarger is a very progressive teacher and student of biological subjects and methods of teaching them. In fact, methods of teaching has been a hobby of his for a good many years. Owing to reorganization of the science work in the school system Mr. Isenbarger has been compelled to meet also drastic changes in the work required of him. But in each case he has been able to adapt his teaching to the work required in a superior manner. Needless to say all this has qualified him for his work on the textbook of botany.

From the foregoing, it is evident the authors did not plan to write just another textbook of botany. Rather, they undertook to plan a book which should embody the ideas adopted by the most progressive teachers of biological sciences. They have therefore emphasized the method of presenting the subject to the student rather than the material of the work. Accordingly, we find the book divided into a series of ten "units" and each unit made up of a series of "problems." Each unit division of the subject and each problem has its part in developing the important principles covered by the science. The units and problems are arranged to convey progressively and logically a clear understanding of the work and value of living plants. The pupil is aided by a "preview" of the entire book and previews or discussion of the units and problems as they occur.

The book is well illustrated with figures designed to assist the pupil to understand the work, rather than as "show off" to sell the book. Laboratory exercises are given for the pupil as needed for the solution of each problem. With each chapter there is a list of reference books. Each reference accompanied with a statement as to the particular value of the book. This is an important innovation to help the student select his reading with intelligence. For the unusually bright and enthusiastic pupils additional questions and exercises are introduced at appropriate points in the development of the problems.

The authors have not neglected the practical aspects of the subject. To quote the preface, "the work in botany should be made practical in the sense that it should supply a basis of fact necessary to the understanding of principles, so that the student can use them in developing within himself a degree of social, civic, ethical and esthetic efficiency."

The course included in this book is designed especially for pupils which have had training in general science of general biology. Teachers of botany will do well to give the book a careful examination. It is an unusually well planned and excellent presentation of an important biological science.

W. WHITNEY

Student's Manual in Biology, by Frederick L. Fitzpatrick, Associate Professor of Natural Science, Teachers College, Columbia University, New York and Ralph E. Horton, Chairman of the Department of Science, Seward High School, New York City. With 28 exercises, and numerous figures, diagrams and tables. Paper cover, detachable leaves, size 20×28 cm. Published by Houghton Mifflin Company. Boston, 1935.

This manual is written for ninth grade work and is planned to be sufficient for a year's work in biology. The exercises are on removable sheets with spaces left for answers. Each exercise is headed by a statement of the purpose of the study and an outline of the materials needed for the study. Where possible choice of material is permitted. Each exercise contains one or more problems for the laboratory work. Blank space is given for each of the several questions involved in the solution of the problem under consideration.

It will, thus, be seen that the work of the class is carefully directed. There is little opportunity for the individuality of the pupil to be exercised. There are a good many figures, and diagrams and tables included, all with the labelling or other work carefully designated for the student, since blank spaces are given for the students notes and the sheets are punched for binding, no other notebook is necessary.

Probably such directed work is advisable for ninth grade students in the case of overworked teachers in small schools and in overcrowded city schools, but the writer would prefer to see more opportunity for individual expression of the pupils personality.

W. WHITNEY

Highlights of Astronomy, by Walter Bartky, Associate Professor of Astronomy, The University of Chicago. Cloth. Pages xiii+280. 16.5×23 cm. 1935. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Illinois. Price $2.50. With Stellarscope $2.00 extra.

This is the third physical science text in the University of Chicago's series of "New Plan" texts. *From Galileo to Cosmic Rays* by Harvey Brace Lemon and *A Mathematician Explains* by Dr. Mayme I. Logsdon have been reviewed in previous issues. Just as in the other "new plan" texts Dr. Bartky's aim was to make the study of his subject attractive to college freshmen, and at the same time to present a sufficient amount of the fundamental subject matter of astronomy to enable students to enjoy and appreciate the subject throughout the remainder of their lives.

It is certainly no easy task to cut the great body of important and interesting astronomical knowledge to a small volume of less than three hundred pages. To include not only the essential subject matter but to embellish it and enrich it with myths, legends, history, and clever illustrations that give an understanding of the vast astronomical distances is the work of master writer. A list of the topics covered will give very little idea of this novel text, because it is the manner of presentation rather than the fundamental content which makes the book so much different from all other textbooks on elementary astronomy.

A very ingenious device called a *stellarscope*, invented by the author and supplied with the text, enables the student to identify the principal stars, and constellations. The text and stellarscope must be seen and used to be appreciated.

G. W. W.

The Book of Minerals, by Alfred C. Hawkins, Soil Expert, Soil Conservation Service, U. S. Department of Agriculture. Cloth. Pages xii+161. 13×19 cm. 1935. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.50, plus postage.

This book is written for the layman and the amateur mineralogist. It aims to tell some of the essentials of the subject in a non-technical way. The first thirty pages tell what minerals are, where to find them, how to

identify them, how to collect and preserve them; a brief discussion of crystals and crystal forms is also given here. The third chapter gives directions for the use of the blowpipe and of the microscope in identifying minerals. The main part of the book is devoted to descriptions of the more common minerals; the physical properties, occurrence, and some of their uses or interesting facts concerning them are given. A brief bibliography is appended to enable the interested student to pursue the study further. The book is attractively illustrated and will serve as an instrument for directing boys and girls to a fascinating hobby or useful life work.

G. W. W.

Directed Activities I, by Samuel Ralph Powers, Teachers College, Columbia University, Elsie Flint Neuer, New Rochelle, New York, and Herbert Bascom Bruner, Teachers College, Columbia University. Paper. Pages iii + 113. 20×28 cm. 1935. Ginn and Company, Chicago, Illinois. Price 40 cents.

This workbook was planned primarily to be used with "The World Around Us" (A Survey of Science, Book One). It may be used, however, with other standard textbooks. The book contains eight units or divisions, each dealing with a phase of our environment. Each unit is subdivided into eight or nine problems related to the larger problem of the unit.

The book contains numerous exercises, and questions that the pupil is expected to work, fill in, and complete. The questions and directions are clear and definite. The drawings are many and excellent. The authors use the "Pivot Work" plan of calling attention to the more important words, at the beginning of each problem. Tests of various types are provided for review purposes at the end of each of the sub problems. Very adequate reference lists are supplied.

This workbook provides a wealth of material that is well organized and carefully analyzed. The title is very well chosen in that it does provide for "Directed Activities." Every teacher of general science can profit by using this workbook.

T. J. KUEMMERLEIN

Holiday Pond, Holiday Meadow and Holiday Hill, by Edith M. Patch. Cloth. 1935. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 96 cents each.

In this series of books the pupil makes his initial step into the grandeur of nature. His glimpse into the work of art going on about us each minute will prove fascinating and wonderful as depicted by this series. Native curiosity and the urge for adventure are aroused and motivated by the author's invitation at numerous suitable occasions for the pupil to get out and perceive the marvels for himself.

The lessons are in story form with each object of nature as the hero or heroine. The name and life are in language companionate to that of the beginner. The material covered in the book follows the seasons of the year. New words which may need additional explanation are introduced to the pupil's vocabulary; such as, stamen, stigma, pollen, pistil.

The type of paper and print are excellent for the eyes of the young student. The size and shape of each book are similar to that of story books. The outside bindings are in bright colors with black lettering making an outstanding appearance. Illustrations are numerous, clear, and quite sufficient. There are no prefaces or indices.

Holiday Pond, the first of the series, consisting of nature life about a body of water, opens with an introductory note of invitation to visit the

pond and count its blessings. A study of frog life follows: next comes the life of the raccoon—mother, father, and babies. The scene shifts from the ground to the air and a lesson on blue damsel flies ensues. "Visitors from the Sea" is the name of a lesson which informs the pupil of the different fish, shells, and weeds which come to the pond over the falls from the sea. A story of a painted turtle and its adventures gives an interesting account of turtle life. Flowers and humming birds make up the next study. Lessons on insect life with its effect on plants follow. A story of the swallow, of the feeders on the pond lily, and of ducks concludes the first unit.

Holiday Meadow, the second of the series, unfolds pictures of the work of nature in the open field. Beginning with the first dawn of spring meadow life is pictured by a story of cows in the daisies, the meadow lark, plant seed scattered by the wind and buried in the soil later to grow as flowers or weeds, caterpillars, the ground hog, and insects called bubble blowers. Summer and autumn life are depicted by lessons entitled "Hay Day," "Star Nose," the life of a star dust mole, and "The Adventures of a Meadow Caterpillar." Concluding the unit with winter scenes are lessons about snow flakes and the effect of snow on bird, plant, and insect life.

The last of the series, *Holiday Hill*, portrays nature on the hill. A lesson about the boulder found at the top of the hill and its origin, opens the study. Plants which grow in uncultivated land are described and explained. A story of squirrel life on the hill follows. From animal to plant life the scene changes giving a lesson on the primrose and the insects feeding on it. A story on the snail and the garter snake come next. The American elm tree and the butterfly's preference for it is the object of the following lesson. The unit concludes with interesting descriptions of bird and rabbit life on the hill.

MARIE E. SHIELDS

A Textbook of Light, by L. R. Middleton, Physics Master, Latymer Upper School, Hammersmith, England. vi+298 pp., 189 figures. 14 cm. by 20.5 cm. G. Bell and Sons Ltd., London. 1935. 6S ($1.46).

This meaty, concise, and rather comprehensive little text should prove quite adequate for an introductory course in our colleges and as an aid to the high school teacher. It is fully illustrated with neat line drawings and supplemented with well chosen questions, the answers to which are given in an appendix. The author demonstrates ability to say much in few words. Plenty of applications are presented but the principles are not submerged by them. With a wide and well balanced view of his field, he has included much that one often misses in more ponderous texts, as, for example, a summary of the causes of the various types of emission spectra and the practical application of each kind of electromagnetic radiation.

The first part of the book is a geometrical treatment with the use of light rays and the second is physical optics based on the wave theory. The quantum theory is also discussed, but briefly, and the dilemma of modern physics is indicated. The vital chapter on the theories of light is well done although some might believe this subject warrants more extensive treatment. The mathematical analysis is adequate but not too difficult.

The book also deserves a place on the shelf of the college laboratory because of its clear presentation of essential apparatus and procedures. The chapter on the spectrometer and its adjustment is excellent; so is that on photometers, even though, with true British conservatism, it rates 4 foot candles as sufficient illumination for reading.

A. H. GOULD

Analytic Geometry, by Charles H. Sisam, Professor of Mathematics, Colorado College. Cloth. Pages xix+310. 12.5×19.5 cm. 1936. Henry Holt and Company, One Park Avenue, New York, N. Y. Price $2.00.

This Analytic Geometry belongs to the traditional type. There are twelve chapters of plane geometry and three chapters of solid geometry. The first six chapters contain the material which is usually considered basic in a course of analytic geometry. The book contains ample material for five semester hours.

The following features deserve special attention.

1. Polar coordinates are introduced in the second chapter and employed consistently in the following chapters.
2. Special attention is given to the construction of graphs. Chapter VIII and Chapter X deal quite fully with higher plane curves and polar curves respectively.
3. There is a lengthy chapter on empirical equations.
4. More attention is given to solid geometry than usual.
5. Topics and problems are provided for the superior student.

J. M. KINNEY

General Mathematics, by Professor Harold T. Davis, Indiana University. Cloth. Pages xii+316. 15×23 cm. 1935. The Principia Press, Bloomington, Indiana.

The author states that this book had its origin in an attempt to develop a course to prepare students for the teaching of arithmetic. "The intention of the course was both to provide a background for the appreciation of arithmetic in its relation to other mathematical subjects and to instruct in actual numerical and algebraic processes."

In its present form the book comprises sixteen chapters with the following headings:

1. Our Number System; 2. Problems in Arithmetic; 3. The Processes of Algebra; 4. The Law of Exponents and Logarithms; 5. Arithmetic and Geometric Series; 6. The Binomial Theorem—Interpolation and Its Uses; 7. Functional Relationships; 8. The Quadratic Equation; 9. Functions of the Theory of Investment; 10. Permutations and Combinations—Probability; 11. The Theory of Equations; 12. The Theory of Proportion—The Ratios of Trigonometry; 13. The Applications of Trigonometry; 14. The Functions of Statistics; 15. Mathematical Recreations; 16. Meaning of Mathematics.

Chapters III to XI constitute a good three hour course in college algebra. Chapters XII and XIII are devoted to trigonometry. The chapters on algebra and trigonometry together furnish material for five semester hours and thus sufficient preparation for a course in analytic geometry.

The book may be used in preparing students for a course in the theory and applications of statistics. Chapters II to XI and Chapter XIV offer appropriate material for such a course. For students with no more than two years of high school mathematics portions of Chapters I to V, Chasters VII, VIII, and IX, Chapters XII to XVI may be used for a survey course in mathematics.

The author has humanized the book by introducing historical material. In Chapters I and II we find several pages devoted to the history of the number system and arithmetic. In Chapter XVI more than five pages are devoted to short accounts of the work of the worlds leading mathematicians. Throughout the book we find numerous historical references.

On account of its adaptability to the needs of so many different classes of students the book should be used quite extensively.

J. M. KINNEY

Tables of Higher Mathematical Functions, Vol. II. Computed and Compiled under the Direction of Harold T. Davis, Professor of Mathematics, Indiana University and the Cowles Commission for Research in Economics. Cloth. Pages xiii+391. 17×25 cm. 1935. The Principia Press, Inc., Bloomington, Indiana.

This second volume is a continuation of the ambitious project of computing tables of higher mathematical functions begun in 1927. The first volume was published in 1933. In the first volume there were 12 tables relating to the Gamma and Psi Functions. In the second volume there are 37 tables covering the Polygamma Functions (derivatives of log (x)), the Bernoulli polynomials and numbers, the Euler polynomials and numbers, and certain functions useful in unweighted polynomial approximation.

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Meeting of the chairmen of the various meetings of the conference and the members of the panels for Monday's sessions.

Monday Afternoon, July 13

General Session—2:00–4:30 P.M.

Opening of Conference—Dr. Thomas E. Benner, University of Illinois.
"A Word of Welcome," Provost Albert J. Harno, University of Illinois.
"The Social and Economic Setting in Which the School Finds Itself," Dr. Charles H. Judd, University of Chicago.
"The Social and Economic Setting in Which the School Finds Itself," Dr. Russell M. Story, Pomona College, Claremont, California.

Monday Evening, July 13

General Session—7:30–10:00 P.M.

"New Developments in Psychology and Their Implications for the Curriculum," Dr. Coleman R. Griffith, University of Illinois.
"Some Philosophical Considerations and Their Implications for the Curriculum," Dr. H. Gordon Hullfish, Ohio State University.

Tuesday Afternoon, July 14

General Session—2:00–4:30 P.M.

"Criticism of Present Day Curricula—the Need for Curriculum Study," Dr. Fred C. Ayer, University of Texas.

Tuesday Evening, July 14

General Session—7:30–10:00 P.M.

"Some Outstanding Curriculum Experiments in the United States," Dr. Fred C. Ayer, University of Texas.

Wednesday Afternoon, July 15

General Session—2:00–4:30 P.M.

"Techniques of Curriculum Study and Revision," Dr. Samuel Everett, University of Illinois.

Wednesday Evening, July 15

Group Meetings by Educational Levels, 7:30–10:00 P.M.

I. *Elementary School Level*
Dr. Eldridge T. McSwain, Northwestern University, Chairman
II. *Junior High School Level*
Mr. B. M. Hanna, Principal. Roosevelt Junior High School, Rockford, Illinois, Chairman
III. *Senoir High School—Junior College Level*
Dr. Samuel Everett, University of Illinois, Chairman

Thursday Afternoon, July 16

Group Meetings by Subject Matter Areas, 2:00–4:30 P.M.

I. *Elementary Subjects Group*
Dr. Eldridge T. McSwain, Northwestern University, Chairman
II. *English Group*
Miss Liesett J. McHarry, University of Illinois, Chairman
III. *Fine Arts Group*
Miss A. Marie Anderson and Mr. Ralph M. Holmes, University of Illinois, Chairmen
IV. *Foreign Language Group*

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